the paper on the metallic telegraph system [5] and, therefore, will not be given in detail here. In a general way it may be said that switches and meters are provided to connect the telegraph batteries to local apparatus, to provide either one-way or two-way service and to facilitate repeating to other telegraph systems.

Capabilities of System

Field tests over the New York-Pittsburgh system have shown that each telegraph circuit derived therefrom is of high grade, allowing signal speeds of 35 to 40 cycles per second. That is, with machine sending, it is possible to transmit 140 to 160 words per minute (five letters and a space per word) each way over each telegraph circuit. Considerably higher speeds may, of course, be obtained by widening the frequency range assigned to each telegraph circuit.

The New York-Pittsburgh system may be used in connection with a multiplex printing telegraph system and three printer messages may then be sent simultaneously in either direction on each carrier circuit. Assuming 50 words per minute as the working speed for each of the three printers a total of 1500 words per minute could be transmitted simultaneously in either direction over the ten circuits.

A simple numerical example will indicate what is technically possible by the application of this type of telegraph system to toll cables. A toll cable 2 5/8 inches (6.7 cm.) in diameter contains about 300 pairs of No. 19 B. & S. gage (0.91 mm.) conductors. Utilizing the phantom circuits this gives a total of 225 four-wire circuits. Counting 30 messages in each direction per four-wire circuit it is evident that it is technically possible to transmit 6750 messages in each direction simultaneously.

The "break" feature of this system is satisfactory. It functions in a manner similar to that used with the metallic telegraph system. It takes about 0.1 second to transmit a "break" signal over a 1000-mile (1610 km.) circuit.

Fields of Application

It will be evident that while the foregoing description assumes that this system is applied to four-wire circuits, it could be readily applied to two-wire circuits by transmitting half of the carrier frequencies in one direction and the other half in the opposite direction. Furthermore, if the impedance characteristic of the line could be reproduced with sufficient accuracy in networks to balance the line at the repeaters, the same frequencies could be transmitted in both directions and as many of them could be so transmitted as the natural "cut-off" of the line would permit.

While the voice-frequency carrier telegraph system has been designed primarily for use on an ordinary telephone circuit, the system may be applied to carrier telephone or radio telephone channels without involving radical changes in either the telegraph system or the telephone circuit to which it is applied.

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[5] Metallic Polar-Duplex Telegraph System for Long Small-Gage Cables, *Electrical Communication*, Vol. III, No. 4, 1925.

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april 1925

A New Keyboard Perforator for the Baudot Printing Telegraph System

By A. E. THOMPSON

European Engineering Department, International Western Electric Company

THE invention by Emile Baudot in 1875, of his multiplex printing telegraph system, marks one of the most clear-cut stages in telegraph history. The fact that in his native country, France, as well as in Great Britain, it is still in extensive use, and that modern multiplex systems have been developed on similar lines, is a tribute to the soundness of the principle it embodies.

A new step forward in the improvement of the Baudot system has been taken by Colonel Booth and Mr. Willmot, of the British Post Office, who have jointly invented an ingenious device which enables a Keyboard Perforator with only three rows of keys, together with a Keyboard lay-out in accordance with standard typewriter practice, to be used for the Baudot five-unit code.

As the Baudot system in its usual form is well known to most telegraph engineers, it will only be necessary here, as a preliminary, to describe briefly its operating features in order to explain the principles and outstanding advantages of the Perforator in which the new invention is embodied.

The Keyboard in general use for manual transmission has five piano-type keys, and the alphabet is signalled by depressing these keys according to the table shown in Figure 1. The first three fingers of the right hand control the keys 1, 2 and 3, and the first two fingers of the left hand, the keys 4 and 5. The same permutations are used for figures, and for other symbols, as for the alphabet. This is made possible by an inversion mechanism in the receiving printer which shifts the typewheel into the desired position upon receipt of a control signal ("Figure space," or "Letter space,") much in the same way as on the ordinary typewriter.

The mechanism by which the signal impulses are transmitted over the line is shown diagramatically in Figure 2. The revolving distributor brushes, *DB*, successively connect the segments of the outer ring to the adjacent continuous ring, and thus to the line. Each of the

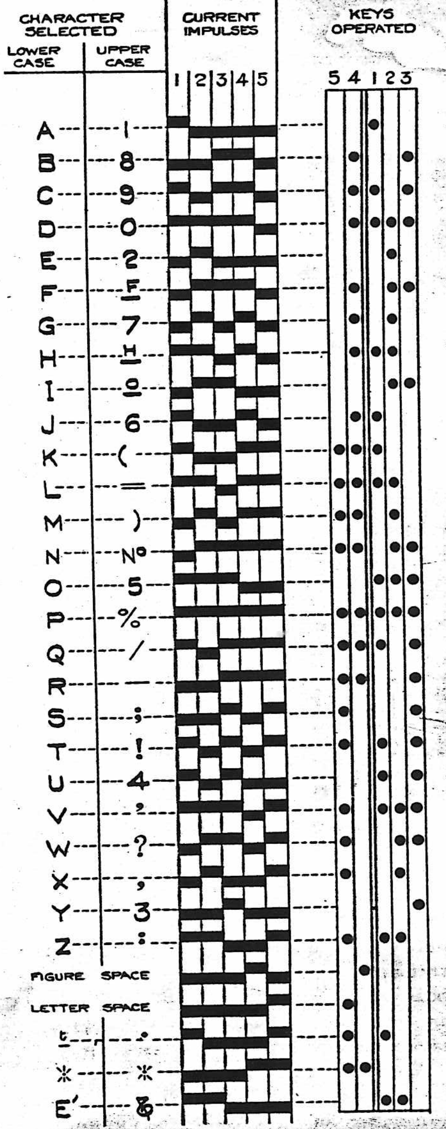

Figure 1

five segments on the outer ring is connected to a signaling key at one end of the line and to an electro-magnet in the receiving printer at the other end. The distributor brushes at the two stations are driven in unison and in phase, so that at every revolution the signaling keys are connected to the line at the same instant as the printer electro-magnets are connected to the armature of the receiving polar relay.

As the keys normally rest against the negative or "spacing" busbar, the armature of the receiving relay is held in the position shown, and the printer is not actuated.

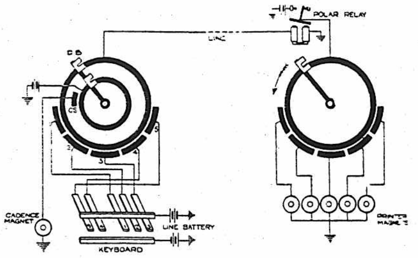

Figure 2—Principle of Baudot Transmission

When one or more of the keys are depressed, a permutation of five positive and negative impulses is transmitted to line, the corresponding printer electro-magnets are energized, and the desired character is recorded.

With this method of transmission it is neecessary first to provide a warning signal, so that the operator may know at what instant to depress the keys. Next, it is necessary to ensure that the operated keys do not rise again until the distributor brushes have passed over the last sending segment. These requirements are met by a "Cadence" mechanism. When the keys are depressed, they are held mechanically by five hooks, until the local brush passes on to the cadence segment *CS*. At this instant an electro-magnet in the keyboard is energized, and its armature releases the keys and gives a warning click to the operator. As soon as the local brush passes off the cadence-segment, the armature falls back and the keys which have been depressed are again locked.

When automatic transmission is used, the five-key keyboard is replaced by a tape-operated transmitter and a keyboard perforator. This method of transmission has important advantages both from the standpoint of line economy and operator ouput.

With direct keyboard transmission, every time the operator stops, to sign and "time" a telegram, the line is idle. With automatic transmission, however, as the operator no longer transmits direct to line, the actual traffic handled more closely approaches the theoretical traffic-carrying capacity of the system. The operators, moreover, are not required to perform the mental task of translating the signals into the Baudot code and to set up the combinations on the keyboard. As this work is done mechanically, the operators need only possess typing skill and, therefore, instead of restricting the speed of the Baudot system to 30 words per minute per channel, as is at present necessary because of operator limitations, it should now be practicable to increase the speed to 35 or 40 words per minute without imposing any additional strain upon the staff.

The Automatic Tape Transmitter, Figure 3, consists essentially of five contact-levers controlled by a paper tape previously prepared by means of the keyboard perforator. The operation of the mechanism is as follows:—

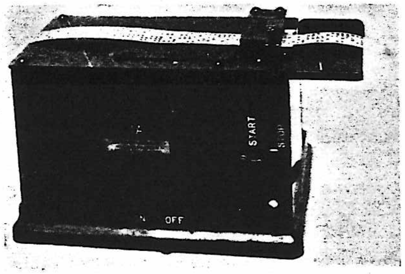

Figure 3

When the local distributor-brush passes over the cadence-segment, the transmitter electro-magnet is energized and its armature first depresses the five selecting pins *SP*, Figure 4, and then the rocker bar *RB*. The rocker-bar raises the pawl *P*, and thus rotates the star-wheel *SW*, stepping the tape forward one character. All the contact levers now rest against the "spacing" bus-bar. Immediately the electro-magnet is de-energized, the selecting pins are free to rise, but they can only do so if there is a hole for them to pass through in the paper tape. The pins which do pass through the tape raise their horizontal arms, *HA*, and their corresponding contact-levers, *CL*, are thus moved over to the "marking" bus-bar: the springs, *S*, being stronger than the contact-lever springs, *CLS*. In this way positive or negative line-battery is connected to the five sending segments, and the signal permutation is transmitted to line in the manner already described.

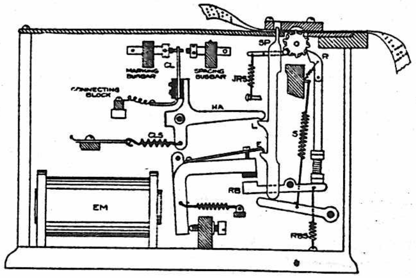

Figure 4—Automatic Tape Transmitter

The general appearance of the keyboard perforator is shown in the photograph, Figure 5, and the novel feature, which it is one of the main objects of this article to describe, is that the machine can perforate two entirely different arrangements of the five unit code. The necessity for this is due to the fact that in the Baudot code the "Upper case" and "Lower case" characters do not correspond to standard typewriter practice and, therefore, if each key controlled only one signal permutation, the figures would be scattered throughout the keyboard instead of appearing in proper sequence in the third row of keys. From an operating standpoint, such a keyboard layout would obviously have serious disadvantages. The difficulty could, of course, be easily overcome by providing an extra row of keys, but in the new perforator this undesirable feature is avoided.

It is also to be observed that each character is perforated across a tape only $\frac{11}{16}$ of an inch

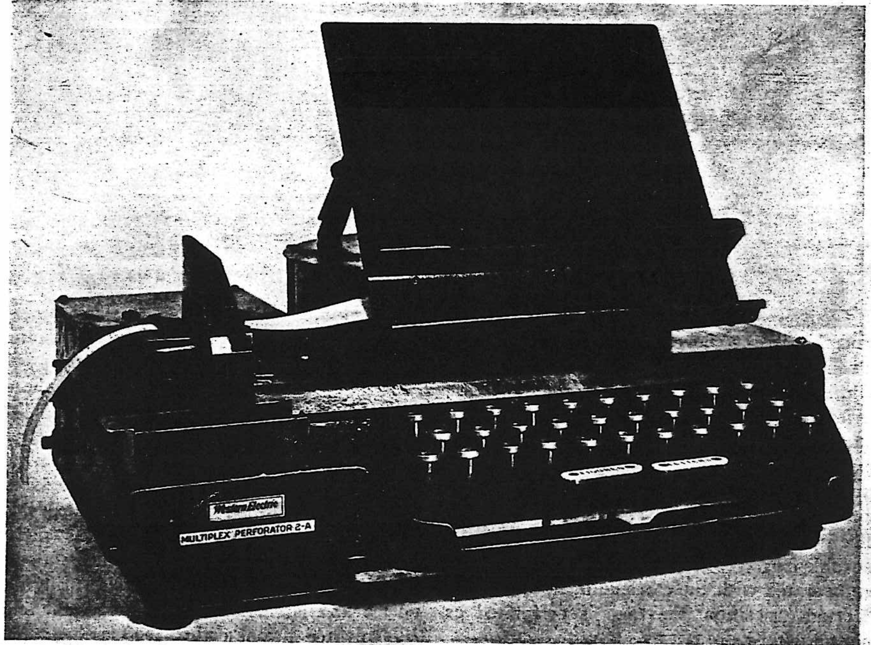

Figure 5

wide, and as the feed forward for each is only $\frac{1}{10}$ of an inch, the Perforator is economical in the use of paper.

Each operating key is mounted at the end of a pivoted key-lever, supported at its center by a spiral spring, Figure 6. Lying transversely beneath the key levers is a movable carriage in which five code bars are mounted, their function being to select the punches required to perforate the paper tape. The code bars are notched in such a way that every key lever operates a different combination of code bars. Furthermore, two different permutations of notches are allotted to each key lever, the one effective depending upon the position of the movable carriage. For example, when the keys are operated with the carriage in its normal or "Letters" position, the tape is perforated as shown at *L*, Figure 7.

When the "Figures" key is actuated, the carriage is moved one-eighth of an inch to the right and the keys then perforate the tape as shown at *F*, Figure 7, as their key levers now have entirely different permutations of notches presented to their lower edge. Thus the keyboard is capable of perforating two different arrangements of the five unit code.

The code-bar carriage is moved into the desired position by operating the "Letters," or "Figures" keys, the levers of which engage a corresponding knife-edge mounted upon the frame of the carriage, Figure 8. The lateral movement of the carriage is controlled by a spring-mounted jockey-roller, *JR*, fastened to the carriage guide-rods, and shock is avoided by suitable buffers. Each code-bar is spring supported and is carried by two horizontal links, *HL*, pivoted to one end of the carriage. This

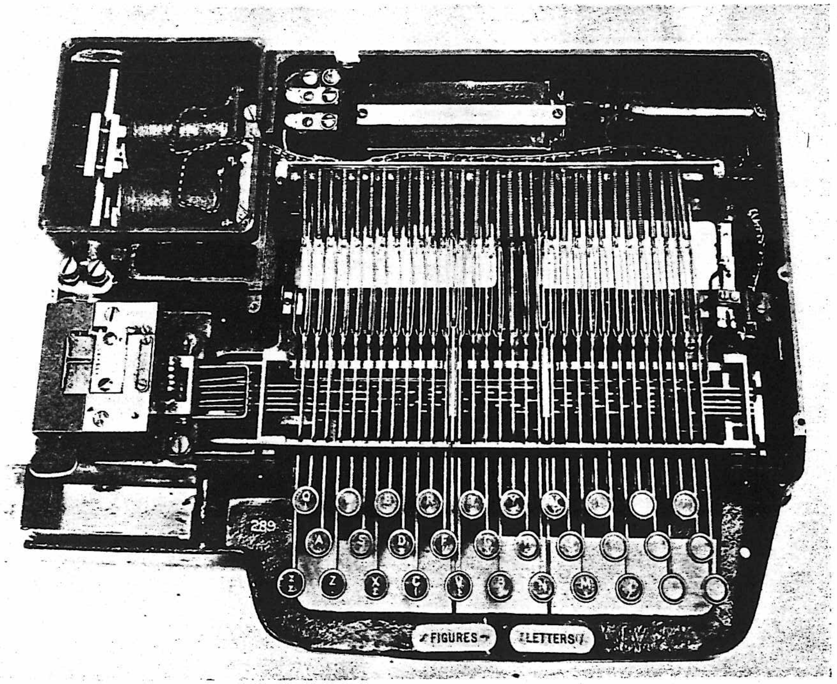

Figure 6

arrangement ensures a perfectly perpendicular movement of the code bars. In addition to the five code bars mentioned, a sixth or "universal" bar, is mounted beneath the key levers. This code bar is actuated every time a key is depressed, and it serves to close two contacts in the circuit of the punch-magnet.

Each of the five selecting code-bars controls a pivoted link, *SL*, the upper end of which is hinged to a selecting finger, *SF*, normally resting between the punch-hammer, *PH*, and one of the five punch-pins, *PP*. The punch-hammer is operated by the punch-magnet, *PM*, and its upward movement is such that it can only force the punches through the tape when a selecting finger rests in its path. It will be observed that the function of the selecting mechanism is to withdraw the selecting fingers from

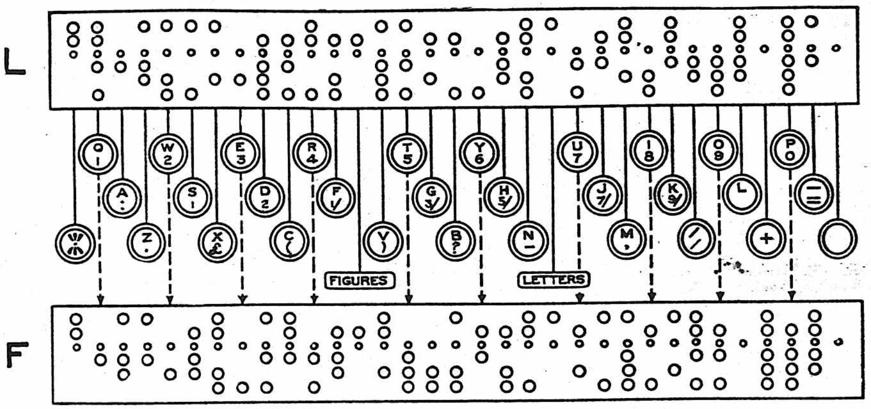

Figure 7

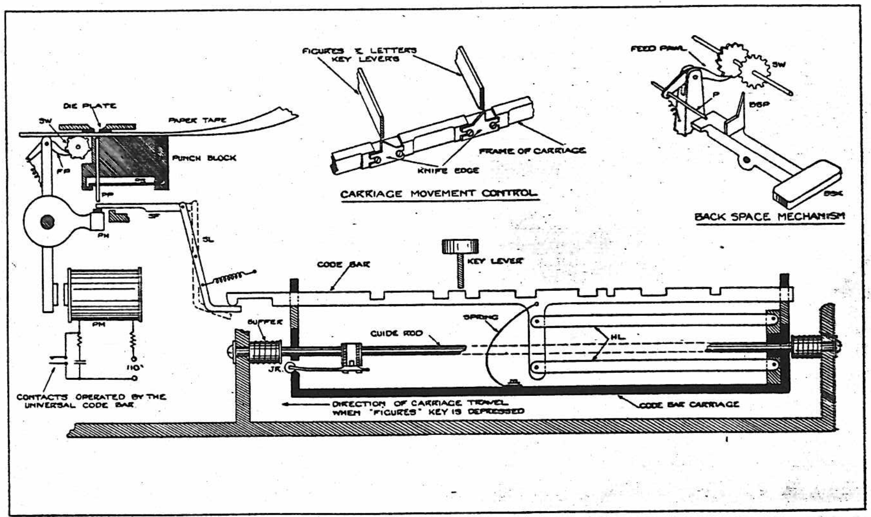

Figure 8

beneath punches not required to perforate the tape.

Each punch is supported by a spring, *PS*. One end of this spring is fastened to the punch-block, and the other end rests against a stop. When a punch is forced through the tape its spring restores it as soon as the punch-hammer is retracted. A sixth punch-pin, less in diameter and longer than the others, is forced upwards every time the punch-hammer is actuated. This punch perforates the small feed-holes near the center of the tape, which are required for the propulsion of the tape through the Perforator, and ultimately through the Transmitter. The feed-holes are engaged by a star-wheel controlled by a ratchet wheel mounted on the same shaft. When the punch-magnet is operated, the feed-pawl (inset Figure 8) is withdrawn out of engagement with the ratchet-wheel, and when it moves forward again it rotates the ratchet-wheel and thus advances the tape in readiness for the next character.

In the event of an operator's finger slipping and inadvertently depressing two keys simultaneously, it is possible to correct the tape. As more than the required number of selecting fingers will in that event have been withdrawn, the tape will have been perforated with fewer holes than the particular character requires. To make a correction, a "back space" key is operated which disengages the feed-pawl from the ratchet-wheel, by rasing the pin *P*, and then causes the back-space pawl to engage the star-wheel and thus to "step back" the tape.

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The Multiplex Printing Telegraph System

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To some the thought of communication by telegraph brings to mind the common picture of a railway station with its telegraph key, and clicking sounder. Few realize that methods have been developed which supersede key transmission and sound reception of messages, so that now messages are received automatically in printed page form, ready for delivery to the public. While the Morse key and sounder play a great part in telegraphing certain classes of work, they have been replaced on most of the trunk lines carrying large volumes of business.

Undoubtedly one of the greatest achievements in the telegraph field in recent years is the development of the so-called multiplex printing telegraph system now used by the Western Union Telegraph Company in the transmission and reception of over 70 percent of its telegraph business between its main operating rooms throughout the entire country. The multiplex system provides a number of equal and independent transmissions or channels over a single telegraph wire.

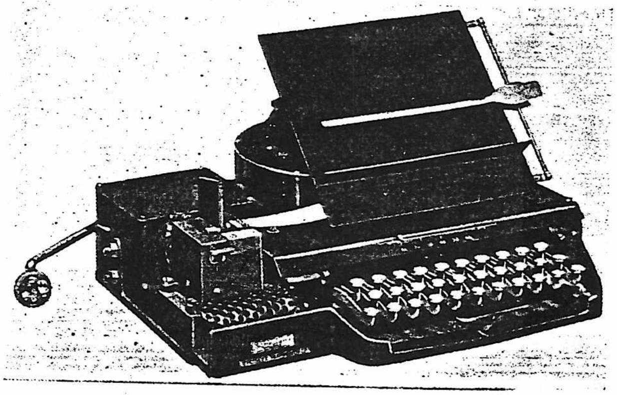


FIG. 1—TAPE PERFORATOR

The principle of the system is to utilize as much of the maximum capacity of the wire as possible, by distributing the use of the line to several automatic-tape transmitters for equal periods of time and in consecutive order.

The signals are automatically translated and recorded in message form by means of telegraphic-printing receivers at the receiving station. The number of channels or transmissions obtainable depends largely on the length and type of the circuit. In the system as developed and shown in the photographs, from two to four simultaneous transmissions in both directions are provided. The basis of the system is:—

1—A duplexed telegraph line by means of which simultaneous transmission in both directions is obtained.

2—Two synchronously rotated distributors, one at each end of the duplexed line, for the purpose of providing several transmissions and receptions during each revolution of their brush arms.

3—Tape transmitters at each end of the line, operating automatically and in proper sequence during each revolution of the distributor brushes, to obtain several equal transmissions.

4—Electrically-operated printers at each end of the line, also operating automatically and in proper sequence during each revolution of the distributor brushes, to obtain several equal receptions in printed form.

PERFORATOR

The perforator, used to prepare the transmitting tape, is an instrument having an arrangement of keys similar to those of a typewriter and a series of five punches and a small feed wheel. These are so mounted that a narrow paper strip or tape may be fed above the punches. A photograph of the perforator is shown in Fig. 1. The depression of each key on the keyboard selects one or more of the five punches in accordance with the code combination of the designated key character and at the same time energizes a magnet which forces the selected punches through the paper tape producing a combination of holes transversely to the length of tape. A sixth punch, smaller than the others, operates with every selection and perforates a small hole along the center of the paper tape. This small hole is for the purpose of feeding the tape along as each character combination is perforated.

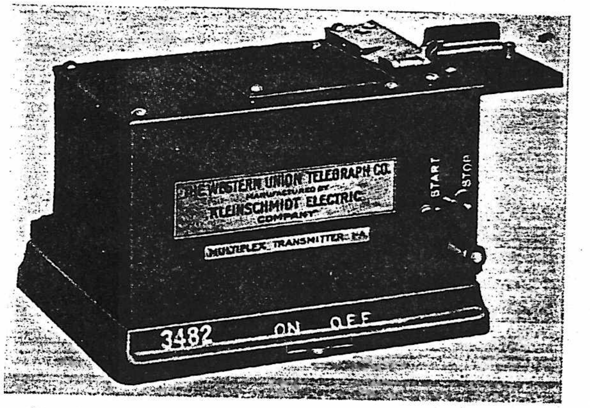


FIG. 2—THE TRANSMITTER UNIT

TRANSMITTER

The transmitter is provided with five small pins mechanically connected to five contact tongues, each of which moves between two screw contacts, one connected to a positive source of current and the other to a negative source of current. The tongues are each electrically connected to a definite transmitting segment on the distributor face-plate or commutator. An electromagnet within the transmitter and operated from the distributor once every revolution permits the five pins to rise to the paper tape passing over them. Where there is a perforation in the tape the pin goes through and thus moves the connected contact tongue to the marking current-contact screw. Where there is no perforation the pin is stopped by the web of the tape and the connected contact tongue remains on the spacing current-contact screw. A photo of the enclosed transmitter unit is shown in Fig. 2.

THE AUTOMATIC CONTROL

Another instrument known as the automatic control, Fig. 3, is an auxiliary or signaling transmitter which operates in conjunction with the regular transmitter and performs its functions automatically, one of which is to stop the feeding of the tape through the transmitter if for any reason the operator does not keep up with the transmitter speed set by the distributor.

The tape as it leaves the perforator forms a loop underneath the automatic control tape lever, before it passes under the tape latch of the transmitter. If the speed of the sending operator is less than that of the distributor (which governs the feeding of the tape in the transmitter as just explained) the loop of tape becomes smaller and smaller until the tension of the tape lifts the protruding tape lever of the automatic control which automatically stops the transmitter from feeding the tape further, locking the transmitter selecting pins against their spacing contacts, and as a result the corresponding distant printer remains idle for a period until the tension of the tape is again reduced. This in turn permits the automatic-control tape lever to drop, so that the transmitter continues its operation from the previous point of interruption. In this way the tearing of the tape is prevented and the message at the distant end is not mutilated.

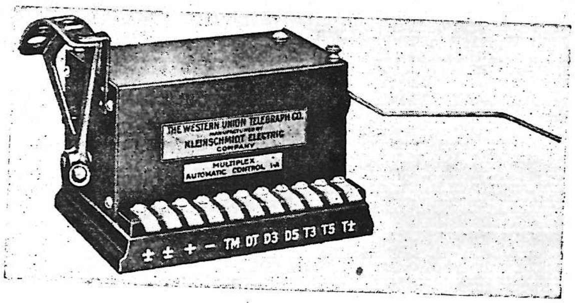

THE WESTERN UNION TELEGRAPH CO.
KLEINSCHMIDT ELECTRIC COMPANY
MULTIPLEX AUTOMATIC CONTROL
± ± + – TM DT D3 D5 T3 T5 T±

FIG. 3—THE AUTOMATIC CONTROL

Other automatic functions of the automatic control are such as to send combinations of bell signals to the distant sending operator to indicate that it is desired to have the message sent over again, or the tape reperforated. When a signal is sent via the automatic control, the regular transmitter is stopped automatically during the transmission of the special bell signals and is automatically started again when the bell signals have been completed.

DISTRIBUTOR

The distributor consists of an impulse motor or LaCour wheel which is driven at constant speed by electrical impulses from an adjustable tuning fork. It consists of a rotor wheel made up of laminated sheets of silicon steel bolted together, having ten flat teeth cut on its periphery and four pairs of electromagnets which surround the toothed rotor wheel. The rotor wheel is mounted rigidly on a steel shaft which drives the brushes of the distributor, and is driven by impulses sent alternately through the electromagnets from the tuning or driving-fork contacts. This type of motor is not self-starting and is therefore usually started by an auxiliary starting motor. A segmented face plate or commutator is mounted on the front of the distributor through which projects the shaft of the motor. The motor shaft carries a brushholder and four pairs of light contacting brushes.

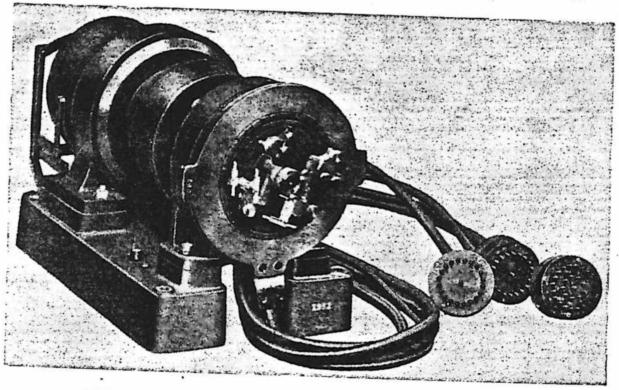


FIG. 4—DISTRIBUTOR MOTOR AND FACE PLATE

The face plate consists of four segmented and four solid rings. One segmented ring takes care of the receiving circuits for printing; one, of the synchronizing circuits; one, of the transmitting circuits, and one is used for operating the local functions. Each solid ring is connected with a corresponding segmented ring by means of one pair of the brushes referred to above to complete the circuit through the moving brushes. As the brushes rotate about the surface of the face plate the brush moving on the third segmented ring from the outside of the plate connects the various segments to the line for transmission. As stated previously these segments are connected through the transmitter tongues to the spacing or marking battery as the transmitter unit operates from the perforated tape.

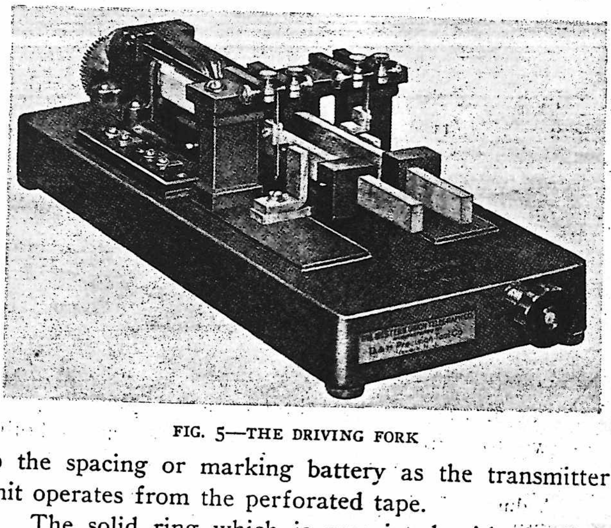


FIG. 5—THE DRIVING FORK

The solid ring which is associated with the first segmented ring receives the signals from the armature tongue of the line relay, which relay receives the signals from the distant station. As the brushes rotate, these signals are passed through the segments of the first ring to the windings of relays in the receiving printer, each segment being connected to one of the five relays or selecting magnets in each printer. Two or more printers are used at each end of the line and one is shown mounted on the left end of the operating table in Fig. 7. The fourth segmented ring operates each of the transmitter local magnets once per revolution of the brushes and feeds the tape to a new combination of perforated holes in the transmitting tape. It also sends a local impulse to the receiving printer for causing the printing mechanism to function after the selection of a character has been made. The second segmented ring is known as the correcting ring and is for the purpose of slightly retarding or advancing the brush assembly at the receiving station to keep the brushes in exact phase relation with those of the transmitting station. This correction is automatically performed by the signals themselves and is more fully described later. The distributor motor with its face plate is shown in Fig. 4, and the driving fork in Fig. 5.

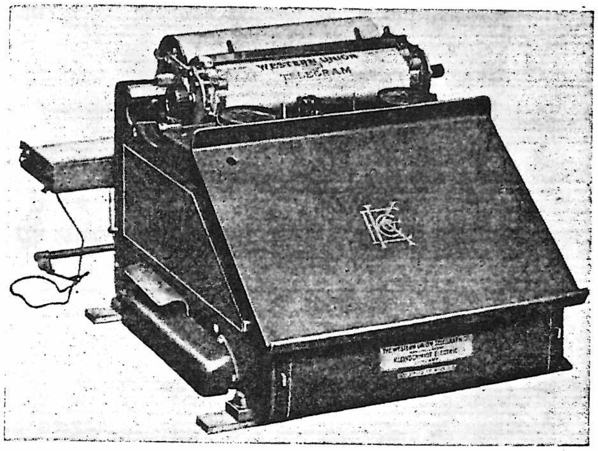


FIG. 6—THE PRINTER

The distributor is equipped with a heavy, mercury filled flywheel, so as to prevent the rotation of the distributor motor from being "jerky," which would be detrimental, for the reason that proper operation of synchronous apparatus requires steady rotation. This flywheel takes up the excess energy imparted to the motor during the short impulses and redistributes this energy over the interval during which no motion is imparted to the armature by the magnets. The wheel is filled with mercury, first, because of its great density, and second, because of its viscosity. When the motor speed falls off, the mercury inside the flywheel tends to continue to rotate, thus causing friction between the mercury and the inside of the wheel. This frictional force tends to prevent the wheel from changing its speed. In the same manner, if the speed of the wheel tends to increase, the frictional force brought into action by the mercury opposes the change in velocity.

The driving fork that furnishes the electrical impulses to drive the distributor motor is comprised of a pair of vibrating tines with their associated contacts and a driving magnet. Once the tines of the driving fork have been set in vibration, by pinching the tines towards each other and then releasing them, they will continue to vibrate at practically a constant rate, due to the energization and de-energization of the driving fork magnet, controlled by the opening and closing of a pair of contacts operated by one of the tines of the fork. The other tine causes additional contacts to deliver current impulses at a uniform and constant rate to the driving magnets of the distributor motor.

PRINTER

The printer is an electrically operated instrument, which by means of electro-magnets, selecting mechanism and type bars, performs automatically all the functions of a typewriter. Each of the selecting magnets is connected to a segment of the distributor face plate. Fig. 6 shows a photograph of one type of printer used in this system. As may be seen from Fig. 7 the message forms used on the printer are printed in a continuous roll of approximately 500 blanks per roll.

The five selecting magnets control the movements of a group of five horizontal selecting bars, each magnet controlling a definite bar. Each bar has notches along its edge so designed and cut, that for any one setting of the five selecting bars, only one group of five notches will be in line vertically. This permits a definite vertical type bar lever to enter the slot formed by the aligned notches. As in the case of the transmitter magnet, once for each revolution of the distributor brushes an operating magnet in the printer is energized locally from a segment of the local ring of the distributor face plate, and by means of a connecting link and printing bail, engages the selected type-bar lever that was permitted to enter the notches and causes it to print the letter.

Immediately after the selected type bar has been engaged by the printing bail, and while the actual printing of the letter is taking place, a connecting link resets it by forcing it out of its slot again. Just as the operating magnet completes its stroke the horizontal selecting bars are reset ready for the next selection.

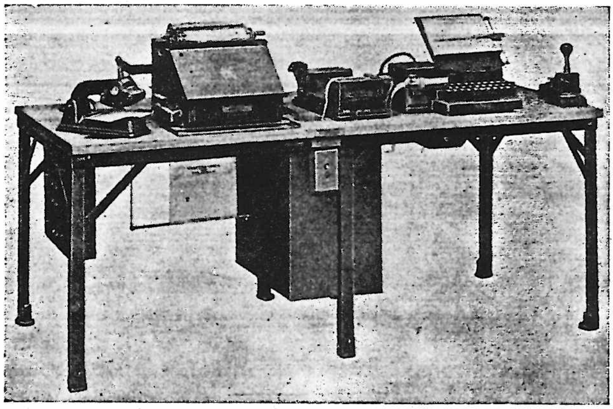


FIG. 7—FULLY EQUIPPED OPERATING TABLE

OPERATING TABLE

The instruments seen on the operating table from left to right in Fig. 7 are an automatic electrically-operated timing and dating stamp for timing the received message; the automatic printer, the transmitter and automatic control, the perforator and a numbering machine for numbering the transmitted message. One sending and one receiving operator are assigned to each operating table.

DISTRIBUTOR TABLE

On the distributor table are mounted the distributor, the line relays, the duplexing apparatus, meters and the tuning or driving fork illustrated in Fig. 8. The cabinet shown at the bottom of the table contains the fuses, switches, resistances, etc., for the various circuits between the distributor table and the operating tables.

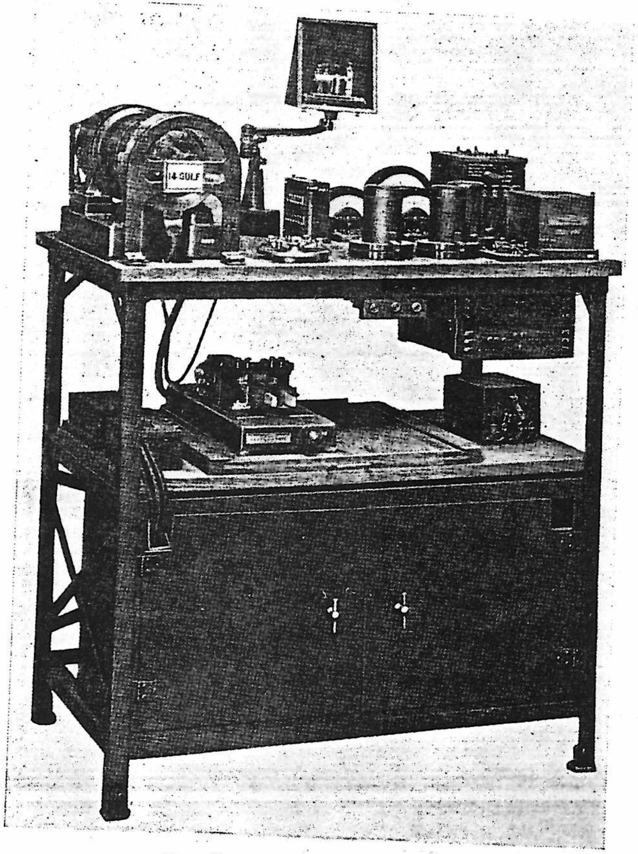


FIG. 8—DISTRIBUTING TABLE

A photograph of a section of a main operating room in a telegraph office showing multiplex installations provided with belt conveyor equipment is shown in Fig. 9. It will be noted from Fig. 9, that the distributor tables are provided with two distributors, each driven by its own individual fork. It is the practice to equip the sets for two distributor operation on long telegraph circuits. One distributor takes care of the transmission and the other of the reception. It is possible by this method to transmit at one speed and receive at another.

OPERATION

Briefly, the operation of the system is as follows:—The message is prepared on the keyboard perforator by the operator, producing a perforated paper tape, the peforations being in accordance with a definite character code combination, as the fascimile of the perforated tape in Fig. 10 shows. This tape passes directly from the perforator through the automatic transmitter and the spacing and marking current equivalents of the perforated and unperforated combinations are set up on the distributor segments and passed over the line by the rotating brushes.

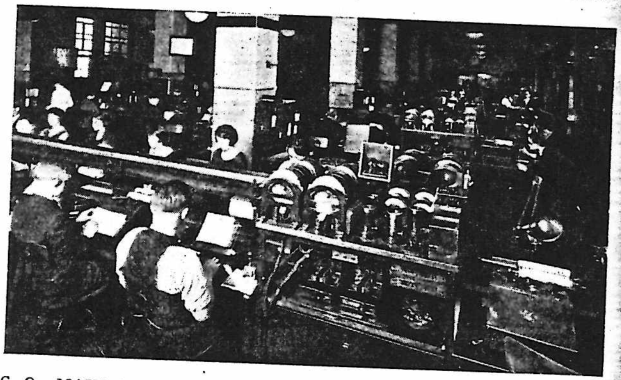
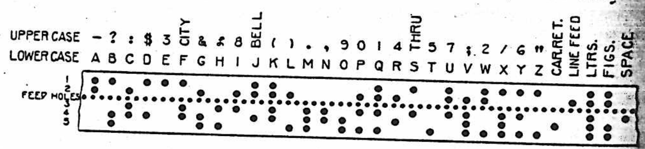


FIG. 9—MAIN OPERATING ROOM OF A TELEGRAPH OFFICE USING THE MULTIPLEX PRINTING SYSTEM

As the distributors at each station are rotating in synchronism and phase, the impulse transmitted on a given segment at one station will be received on the corresponding segment at the other station and will affect the proper printer selecting magnet and cause the printer to function for the character corresponding to that particular impulse. This operation is the same for each transmitting and receiving position or channel and takes place on each of the several positions during one revolution of the brush arms of the distributor.

The designations shown in Fig. 10 as "City" and "Thru" on the upper case position of the letters F and S respectively are for the purpose of controlling switching mechanism in the printer of an auxiliary device known as a reperforator which may be used when desired. If a group of messages are to be delivered from the terminal at which they are received, the "City" combination is perforated preceding that group and the printer then functions normally to print the messages ready for delivery. Should there, however, be messages for a point beyond that terminal, the "Thru" combination may be perforated preceding such messages which will result in the reception being switched from the printer to the reperforator and the message will then be recorded in perforated tape form. This


UPPER CASE
– ? : $ 3 CITY & £ 8 BELL ( ) . , 9 0 1 4 THRU 5 7 ; 2 / 6 "
LOWER CASE
A B C D E F G H I J K L M N O P Q R S T U V W X Y Z
CAR.RET.
LINE FEED
LTRS.
FIGS.
SPACE
FEED HOLES
1
2
3
4
5
FIG. 10—CHARACTER CODE COMBINATION AS PUNCHED BY THE PERFORATOR

perforated tape may then be inserted in a transmitter on another circuit and retransmitted to another point without further preparation or manual handling.

In Fig. 11 is shown a theoretical schematic circuit diagram of the entire system. For clearness the face plate or commutator is shown in its developed form. It will be noted that only two of a possible four of the receiving printers are shown at one end of the line in schematic form and connected to the receiving ring. At the other end of the line two corresponding transmitters marked "XTR-'A' and XTR-'D'" are likewise connected to the sending ring of the distributor. Two other transmitters, XTR-'B' and XTR-'C', also in schematic form are shown but their tongue connections to the segments are omitted in the diagram.

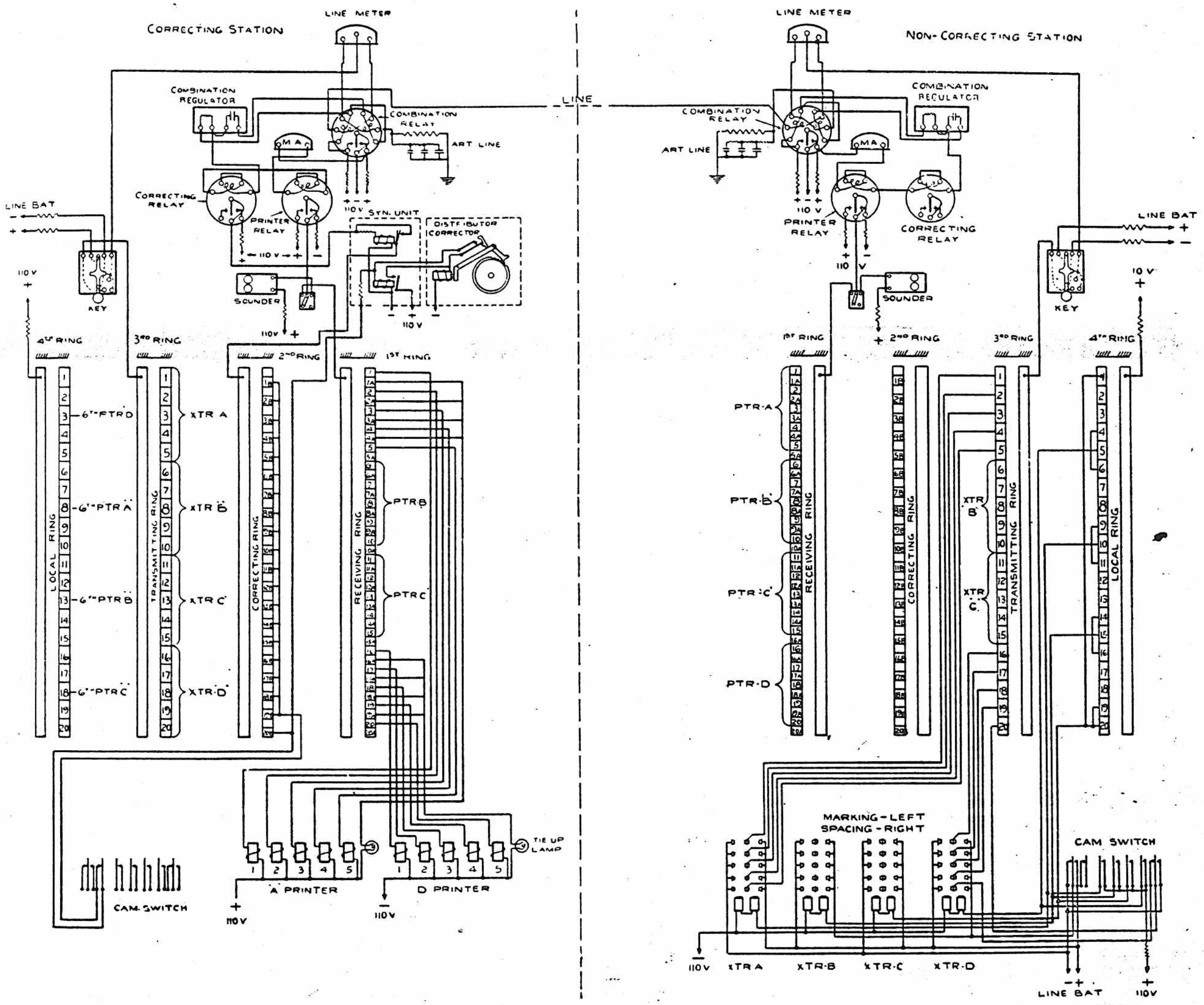


FIG. 11—SCHEMATIC DIAGRAM OF THE MULTIPLEX CIRCUIT

By the arrangement shown and the use of the duplex method it is possible to transmit over one telegraph line as many as four messages in each direction at the same time, the messages being automatically received on the electromechanical printers in typewritten characters on a telegraph blank ready for delivery to the person to whom it is addressed. While we speak of four messages at the same time, we actually transmit a character of each message during each revolution of the distributor brushes, in rapid succession. The distributor is in fact a switching device which automatically connects the telegraph wire in consecutive order to each operator's position so rapidly that it appears to be a simultaneous operation. Thus, when the rate of transmission is sixty words per minute for each transmission, each of the four operators has the use of the line wire six times during each second.

The principle of duplexing the wire makes possible simultaneous transmission in each direction. Briefly, this principle is to make the line relays at each station non-responsive to the signals transmitted from its own station but responsive to the signals from the distant station. This is done by providing the relay with two equal windings and connecting one winding to the real line and the other to an artificial line and causing the transmitting current to pass through these windings in opposite directions. The artificial line is then adjusted to practically the same electrical characteristics as the real line, which produces what is known as a balanced condition. The transmitting current passing through the relay windings in opposite directions produces no effect upon the relay and it therefore does not respond to the signals leaving that station. The current received from the distant end, however, which passes through only one winding of that relay, causes it to respond to the distant transmission. In practice, the sending and receiving currents in the line relays are more complex but the resultant remains the same as outlined above.

It can be readily understood that to be able to receive the various messages correctly and upon the corresponding printers, the speed of reception must equal the speed of transmission, that is, the two stations or terminal offices must operate in synchronism. One of the characteristics of a tuning fork is that once set in motion, it vibrates at practically a constant rate. This is taken advantage of by mounting contacts on the vibrating tines of the tuning or driving fork and causing these contacts to deliver current impulses at a uniform and constant rate to the driving magnets of the distributor motor, thereby causing the distributor brush arms to be rotated at a constant rate of speed, the rate depending upon the position of a pair of weights which are movable along the tines of the driving fork.

In actual practice, however, instead of endeavoring to run the two distributors at exactly the same speed, it is customary to adjust the movable weights on one of the driving forks, so that the speed of one distributor is slightly greater than that of the other, and the brushes of the faster distributor are then retarded at periodic intervals, without altering the constant speed of the distributor rotor. This is accomplished by employing the received signals themselves to operate a correcting relay which in turn furnishes correction impulses to operate a mechanical corrector, located on the faster running distributor, at such frequent intervals as to keep the distributors within very close speed limits. The mechanical corrector is uesd as a connection between the motor shaft and the shaft that carries the distributor brushes. Its function is to rotate one shaft with respect to the other when the two distributors depart slightly from their synchronous relation.

It will be noted from Fig. 11 that the correcting relay operates in a local circuit from the contacts of the main line relay, and it in turn controls the operation of additional relays in the synchronizing unit (shown as "SYN. UNIT" in the diagram.) One of these relays controls the circuit of the magnet of the mechanical corrector of the distributor which, when it is energized, operates a pawl against a ratchet and turns a small pinion wheel one tooth. This magnet becomes energized only at such intervals when the brushes on the synchronizing rings of the faster running distributor have advanced far enough to permit an impulse to be received from a "live" synchronizing ring segment by the "make" relay of the synchronizing unit. When the magnet of the corrector is thus operated, by the energization of this "make" relay, the pinion of the mechanical corrector rotates one tooth along the circumference of a larger gear mounted on the shaft of the distributor brushes. These two gears are the only means of mechanical connection between the rotor of the distributor, on which the mechanical corrector is mounted, and the shaft carrying the distributor brushes. It will therefore be seen that by the operation of the corrector, the relative position of the rotor shaft and the brush shaft is changed, and as the brush shaft gear has 240 teeth, the relation of the two shafts is changed by 1½ degrees for each operation of the corrector magnet. When the corrector magnet is operated, its pinion advances one tooth over the brush shaft gear in the direction of rotation of the brushes and the net effect is as though the brushes were momentarily stopped and then continued in rotation. It is thus seen that by this correction, the brushes are momentarily retarded, while the speed of the distributor rotor is in no way affected. As stated before, these corrections take place at such frequency as to keep the relative positions between the brushes of the two distributors within very close limits.

The first cost of a multiplex installation is high, especially when compared to the ordinary Morse duplex installation and for that reason this system of communication is confined to circuits where the volume of business that will be handled justifies the expense. Such an installation consists of a distributor table and a number of operating tables fully equipped as shown in the preceding photographs.

Each operating table comprises apparatus for one transmitting and one receiving channel. It may be desirable, for example, where the volume of traffic and length of circuit warrants it, to have an installation at each terminal station of a line comprising one distributor table and four operating tables, such a circuit being called "Quadruple". This provides equipment for sending and receiving four messages at each end of the line.

For traffic reasons it may be more desirable to operate a circuit with three channels of communication, in which event the installation at each terminal will comprise one distributor table and three fully equipped operating tables. Such a circuit is known as a "Triple". Then again, if the volume of business does not warrant a "Triple" or "Quadruple", or the characteristics of the line are such that it is found inexpedient to attempt to operate the circuit either as a "Quadruple" or a "Triple", a circuit may be provided for two channels of communication, in which event the installation at each terminal will comprise one distributor table and two fully equipped operating tables, such a circuit being known as a "Double".

It has been stated that besides the volume of traffic, the line characteristics also determine the type of circuit, that is, the number of channels of communication.

The line characteristics are affected by the resistance of the line, self-induction, mutual induction, induction from power or other foreign circuits, capacity, leakage to earth, "cross-fire" or leakage from wire to wire, and earth currents. The longer the line the greater the effect of these factors upon the signals, so that it becomes necessary to operate long circuits through automatic repeaters. These repeaters receive the comparatively weak signals and strengthen or regenerate them for the next section.

In all cases a ready means of removing a piece of apparatus that may have become defective is provided by equipping such apparatus with terminal connecting clips which fit underneath and make contact with corresponding table connecting clips so that if any such equipment is suspected of being faulty it may be easily replaced by other apparatus known to be in working order without touching any of the connecting wires associated with the apparatus.

The multiplex system readily lends itself to an adaptation whereby it is possible to branch off channels of communication from the main trunk circuit. For example, in a triple circuit, three trunk line channels of communication are established between terminals *A* and *C*. It is possible for other practical purposes to convert this circuit so that two channels of communication are established between the terminals *A* and *C*, one channel from *A* diverted to an intermediate station *B* and finally a channel picked up from the intermediate station *B* to the other terminal *C*. Such an arrangement requires, of course, additional automatic equipment at the intermediate office *B*, similar to that at *A* and *C*, except that the distributor tables at *B* are wired and equipped for the repeating of signals, which is done by means of a bank of five polarized relays. These five relays do the duty for all the repeated channels, one terminal of the first relay coil being connected in multiple with the first segment of each of the repeated channels, etc. It is also possible to extend a channel from a terminal, by means of suitable apparatus, to a branch office or outlying point. At the branch office much simpler apparatus than that used on the main circuit is used.

The multiplex system is operated on circuits of various lengths throughout the United States, the longest being between New York and San Francisco with twelve intermediate automatic repeaters. The system is also operated on the trans Atlantic cables between New York and London providing two channels of communication for each cable. During the California Diamond Jubilee, the London cable circuit was connected direct to San Francisco for demonstration to the San Francisco Chamber of Commerce through twenty-one automatic repeaters, requiring no manual handling of messages at intermediate points.

Characteristics of Single-Phase Motors

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IN the neighborhood of one and one-quarter million small single-phase motors will be manufactured this year in the United States. On first thought this may seem to be an extremely large number of motors, however, it is probably a conservative estimate. A very large percentage of these motors will be used to operate household appliances such as washing machines, oners, pumps, water systems, refrigerators, oil burners, utility motors, etc. Probably half a million of these motors will be used on washing machines. Two irly new developments which use a large number of otors are domestic electric refrigerators and domestic oil burners.

Since these motors are so universally used, it is sirable to know something of their characteristics. It is the purpose of this article to give the general theory of some of the more commonly used motors a to discuss their characteristics. The motors which will be discussed are the well known split-phase motor, the repulsion motor, the repulsion-start induction motor an the repulsion-induction motor.

SPLIT-PHASE MOTORS

A large percentage of the small single-phase motors are of the split-phase, cage-wound induction type. The split-phase motor is the simplest and most rugged of the single-phase motors. The secondary winding is of the usual squirrel-cage type, the same as is used in small polyphase motors. The primary winding is usually of the concentric coil type and is arranged in the slots to give a satisfactory flux distribution. The flux distribution may be changed by changing the number of slots in which the winding is placed or by changing the number of conductors in the slots. Single coils, of the same type as those used in polyphase motors, may be used and arranged to give a flux distribution the same as that obtained by using concentric coils. Either the stationary part of the rotating part may be made the primary, however, most manufacturers make the stationary element the primary.

The single-phase induction motor has no inherent starting torque. A polyphase motor connected to a source of polyphase power has a so-called rotating

April 5, 1927. F. M. CARROLL 1,623,163

CARD CONTROLLED PRINTING MACHINE

Filed Dec. 12, 1922 3 Sheets-Sheet 2

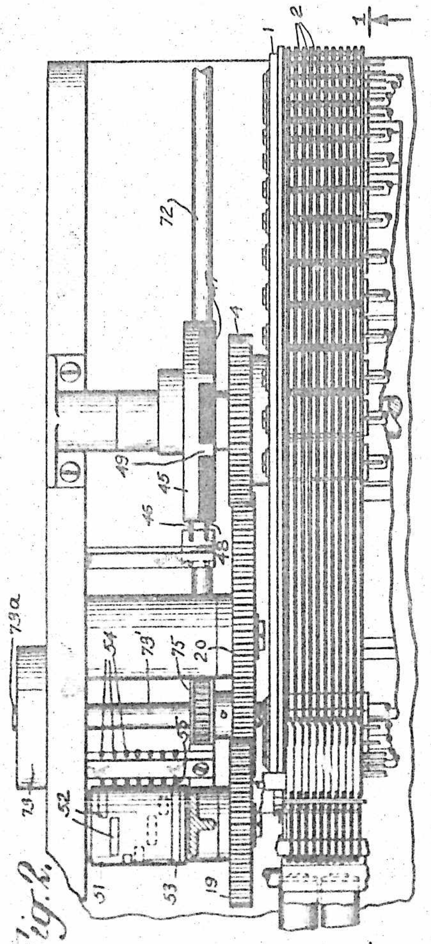

Fig. 2.

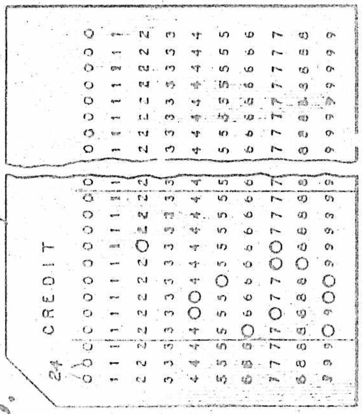

Fig. 6.

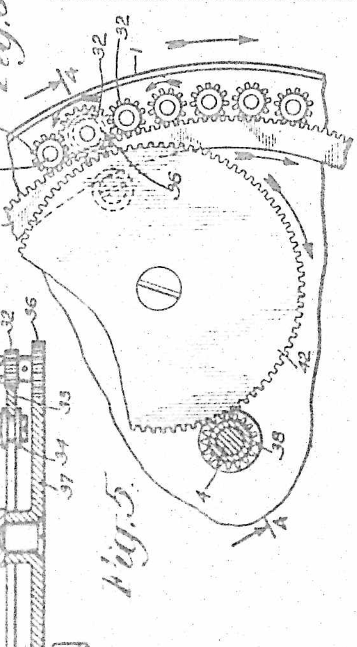

Fig. 5.

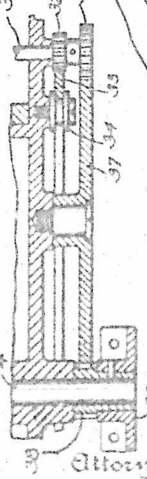

Fig. 4.

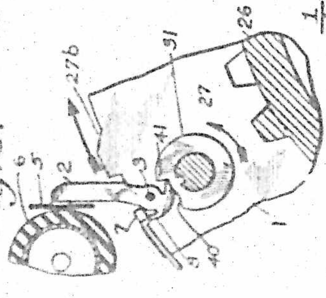

Fig. 3.

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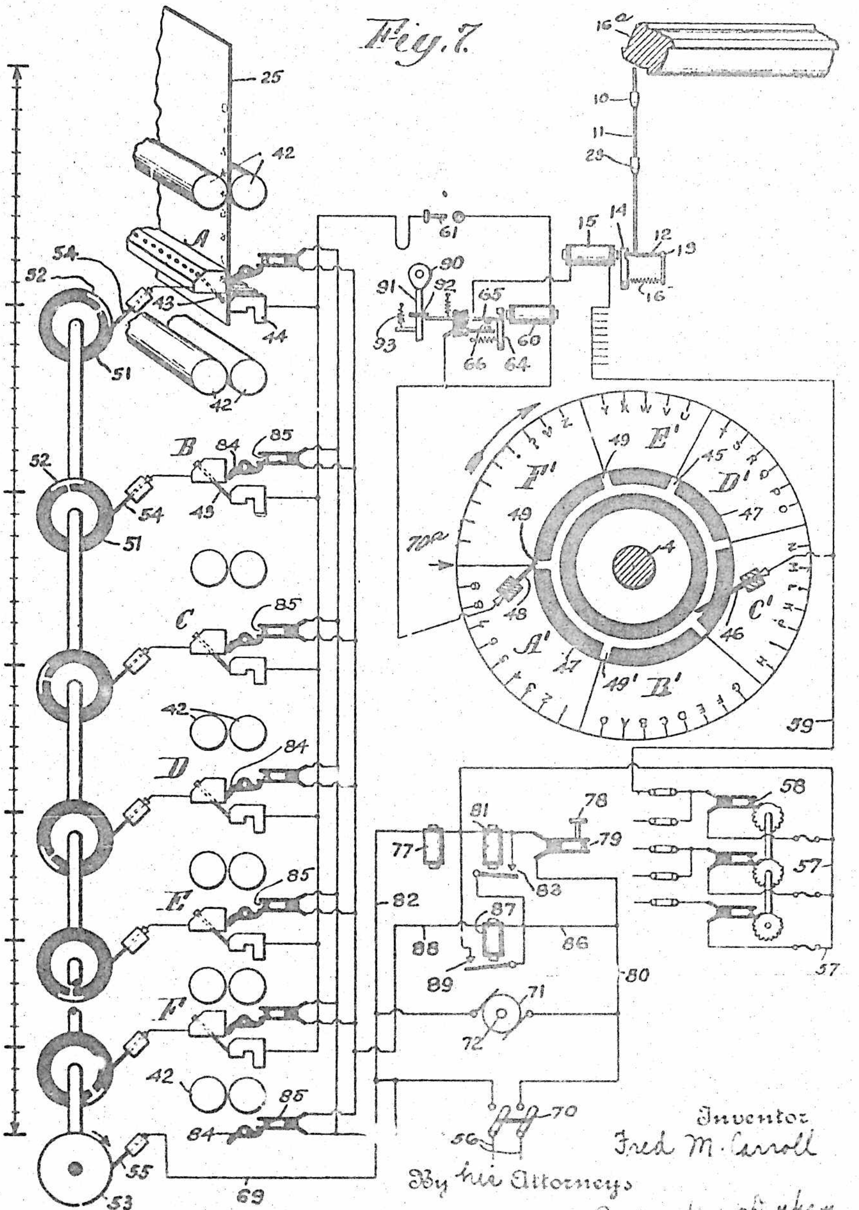
CARD CONTROLLED PRINTING MACHINE

Filed Dec. 12, 1922 3 Sheets-Sheet 3

Fig. 7.



Inventor
Fred M. Carroll
By his Attorneys
Cooper, Kerr & Dunham

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Patented May 8, 1928.

1,669,238

UNITED STATES PATENT OFFICE.

HARRY T. GOSS, OF RUTHERFORD, NEW JERSEY, ASSIGNOR TO THE TABULATING MACHINE COMPANY, OF ENDICOTT, NEW YORK, A CORPORATION OF NEW JERSEY.

ALPHABETICAL SORTER.

Application filed December 3, 1924. Serial No. 753,561.

This invention relates to improvements in machines for sorting perforated record cards such as are used in tabulating machines, especially cards punched according to the Peirce alphabetical code.

In the Peirce system the reading position is a particular zone on a card, and the perforations are variously arranged in that zone instead of being positioned anywhere in a card column extending from top to bottom of the card, as in the Hollerith system.

My present invention is an improvement on the machine described in detail in co-pending application Serial 695,000, filed February 25, 1924 on behalf of E. A. Ford which discloses a sorting machine designed to segregate in one run cards of the Hollerith type having certain combinations of holes in a plurality of columns.

My invention covers a sorting machine designed to segregate in one run cards having a certain individuality as represented by a particular combination of perforations on the card. For instance, it may be desired to separate from a promiscuous stack of cards all those bearing the name "Brown", or all those bearing the name of a certain town, such as "Atlanta", and that is the kind of work this present invention will do. It sorts cards electrically while the cards are in motion, depositing the segregated cards in one stack and the rejected cards in another stack. My machine works rapidly, is easy to change from one set-up to another, is simple in construction, and inexpensive to manufacture. Further and other advantages will hereafter appear in the accompanying specifications and claims and in the drawings, which by way of illustration show what I now consider to be a preferred embodiment of my invention.

In the drawings,

Fig. 1 is a sectional view of the machine.

Fig. 2 is a front view.

Fig. 3 is a sectional view on line 3—3 of Fig. 2.

Fig. 4 is a view of the card deflecting mechanism in deflecting position.

Fig. 5 is an enlarged view of a plugboard detail.

Fig. 6 shows a typical perforated Peirce record card.

Fig. 7 shows the electric circuits of my machine.

Fig. 8 shows a side view of a modification of my invention designed to sort cards punched according to the Hollerith alphabetical code.

Fig. 9 is a front view of the modification in Fig. 8.

Fig. 10 shows a portion of a Hollerith card punched according to the Hollerith alphabetical code.

In the drawings, 20 is the magazine containing a stack of record cards from which the cards are fed one by one, at regular intervals, by the picker mechanism 21, into control of the positively driven conveyor rolls 22. In their passage downwardly through the conveyor and analyzing device the cards are guided by slots in the edges of fixed plates 23.

After a card leaves the bottom rolls of the conveyor it passes normally into control of a stacking device shown conventionally at 24 and is deposited thereby on the stack of reject cards 25. If, however, the card has the predetermined combination of perforations for which the analyzing device has been adjusted by the operator, the card, as it emerges from the last pair of rolls, is acted upon by the blades 26 and is deflected thereby to the left of partition 27 and deposited on stack 28 in receiving pocket 29.

Deflecting blades 26 are fixed to shaft 30 and are adapted to be rocked anti-clockwise into deflecting position by spring 31, when permitted by cam 33. Fingers 32, also fast on shaft 30, bear on cam 33 which is fast on one of the conveyor roll shafts.

Also fixed to shaft 30 is an arm 34 which engages a notch in armature 35 of magnet 36. These parts are normally held in latched position by spring 37, as in Fig. 1. While the deflector is in this position all cards will pass to the reject pile.

When sorting magnet 36 is energized, armature 35 is drawn to the right, arm 34 is unlatched, and fingers 32 rest on cams 33, as in Fig. 3, and deflector plates 26 are rocked by spring 31 at the proper time in the machine cycle to direct the card into pocket 29.

The foregoing devices are commonly used

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in card sorting machines and require no further description.

Analyzing device.

The gear trains which drive the feed rolls include upper and lower pairs of gears 38 and 39 respectively. A crank 40 is fast to each stud on which upper gears 38 are mounted, and a similar crank 41 on each stud of lower gears 39. Cranks 40 carry cross shafts 42 and 43, while cranks 41 carry cross shafts 44 and 45. Mounted on cross shafts 43 and 45 is a pair of side bars 46, and on shafts 42 and 44 a pair of similar side bars 47.

Supported by lugs 48 on bars 46 is a plugboard 49, and in a similar manner, plugboard 50 is carried by parallel bars 47. These plug-boards are made of non-conducting material such as bakelite and are perforated so that each hole corresponds to an index position on the card. Each hole in the plug-board is provided with a shell portion 50^a adapted to receive a plug assembly 50^b (see Fig. 5). The plug assembly is preferably removably secured in the plug-board shell by means of a bayonet joint 50^c. Each plug assembly comprises an outwardly spring-pressed contact plug 52 and a tap portion 51. It will be understood that the plug assemblies can be changed in their locations as desired and in accordance with the index perforations which are to be sensed. To facilitate removal and insertion of the plug assemblies they may be provided with suitable knurled heads as shown in Fig. 3.

When the machine is in operation the cranks 40 and 41 revolve in the direction indicated by the arrows in Fig. 3, bringing the two plug-boards into close proximity with each other once during every card cycle. Their movement is so synchronized with the balance of the mechanism and the card travel, that, during the time they are together and moving practically parallel with each other and with the card, every hole in both plug-boards registers with its corresponding card index position, and if any taps 51 are in position in the plug-boards their spring plugs 52 will contact with their corresponding index positions on the card. If there is a perforation in the card at any such index position the plug 52 will pass through that perforation.

The card.

Fig. 6 shows a typical record card bearing information punched therein according to the Peirce alphabetical code. For purposes of explanation the translation of the perforations in each zone is printed above the perforations. It will be noticed that holes are punched in six horizontal rows, and that there are either one, two, or three holes, in various positions, in each column. It is evident that holes in index positions 3, 4, and 6 always mean "A"; holes at positions 1, 2 and 5 mean "B"; a single hole at position 6 means "0", while holes at 3 and 5 mean "3", and so on.

The electric circuit.

Referring to the circuit diagram (Fig. 7), 53 is a switch admitting current from an outside source to the lines 54 and 55. 56 is the motor, controlled in the manner customary in machines of this character. Depression of start key 57 closes a circuit from line 54 through the two stop keys 58, through relays 59 and 60 to line 55. Energization of relay 60 closes the motor circuit, which, after start key 57 is released, is maintained by card lever contact 61 as long as cards are passing. Relay 59 closes this circuit when its magnet is energized. The motor will be stopped automatically by the opening of contacts 61 when the supply of cards is exhausted, or it may be stopped at the will of the operator by depressing either stop key 58.

The sorting circuit includes sorting magnet 36 and cam contact devices 63 which are those generally used in machines of this class to make the circuit during the passage of a card and break it again at a fixed point in the cycle. From the right side of the contact combination 63 one wire 64 leads to the contact point of a relay 65 connected to the line 55, while another wire 66 leads to the analyzing device. If contact is established through the analyzing device current will flow through inlet wire 66 and outlet wire 67 to relay 65 which will be energized and will maintain a stick circuit in magnet 36 through wire 64 after the contacts through the cards are separated, thereby preventing arcing at the cards. This circuit is finally broken at a set time in the machine cycle by contact device 63.

Operation.

By way of illustration, I have assumed that the operator has a promiscuous stack of cards and wishes to segregate all those bearing the name "Brown". To accomplish this he wires the plug-boards 49 and 50 by means of taps 51 and their connecting wires so when a card bearing the combination of perforations meaning "Brown" is in the analyzing device every plug 52 in plugboard 49 will be in contact with its corresponding plug 52 in plugboard 50 through a hole in the card, and a series circuit will therefore be established through inlet wire 66, the plug-board wiring, and outlet wire 67, so that sorting magnet 36 will be energized and that card will be sorted. This circuit may be readily traced in Fig. 7, in which plug-board 50, although normally straight behind board 49, has been, for descriptive

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purposes, swung up to a position above 49. Current passes from wire 66 through front tap No. 1 in the B column, comes out through the corresponding rear tap, and passes by the tap wire in the rear to rear tap No. 2 in the B column, from which it emerges through the corresponding front tap No. 2, then passes by front tap wire to front tap No. 5 in B column, and after coming out through the rear No. 5 tap it passes to the No. 5 tap in the next column, and so on, passing through all taps in series, spelling out the letters of "Brown" and finally emerging from rear tap No. 6 in the N column and passing by wire 67 to relay 65.

Now if the cards to be sorted are placed in magazine 20 and the machine started by pressing motor start key 57 the cards will be fed at regular intervals to conveyor rolls 22 and while passing downwardly through the conveyor each card will be examined by the analyzing device above described. If the name "Brown" does not appear, the sorting magnet will not be energized, and the card will pass straight ahead into control of the stacking device and will be deposited thereby on the "reject" pile. If, however, the name "Brown" does appear, in the proper location on the card, the circuit will be completed as above described, sorter magnet 36 will act, and deflector blades 26 will direct that card to the left of partition 27 so it will finally rest on pile 28 in pocket 29.

If it be desired to sort under control of some combination of perforations in the bottom half of the card, another set of plug-boards is installed in the position indicated by the broken lines in Fig. 2, and are wired for the desired combination of perforations.

Modification.

Figs. 8, 9, and 10 show a modification of my present invention. For purposes of illustration this modification is shown as adapted for sorting cards according to the Hollerith alphabetical code. Plug-boards 49 and 50 are replaced by sets of parallel bars 69 and 70 respectively, there being one bar for each column of index positions on the Hollerith card. Bars 69 are of nonconducting material, while bars 70 are of metal, insulated from each other and from their supporting shafts 12 and 14. Each bar 69 carries two settable clips 71, each provided with a contact spring 72 and with a screw 73 for attaching a wire 74, also a locking device as indicated at 75 to secure the clip to its bar. Each bar 69 has a marked position for each row of index positions on the card, also an extra position S below the 9 row, all as indicated on the bar 69 furthest to the right in Fig. 9.

In the Hollerith alphabetical code the letters are each represented by one or two perforations at particular index positions in the card column. The perforations in Fig. 10 spell the name "Brown", "B" being represented by holes in XX and S positions, "R" by a single hole in row 4, "O" by a single hole in row 3, "W" by holes at 5 and 9, and "N" by holes in rows 2 and 9.

To separate from a promiscuous stack of cards those having the above perforations, the operator sets his clips 71 and connects them with wires 74, all as shown in Fig. 9. The path of the sorting current is through wire 66 to clip at XX position then down the 69 bar to clip at S position, thence by wire 74 to clip at S position on the next bar, thence through the bar to clip at position 4, thence through a wire 74 to clip on the next bar, and so on, until it finally emerges on wire 67.

It is evident that only the combination of holes representing "Brown" will allow completion of the sorting circuit, consequently, as promiscuous cards are passed through the device only those punched "Brown" in the last five columns of the Hollerith card will be sorted, all others being rejected.

In accordance with the provisions of the patent statutes, I have herein described the principle of operation of my invention, together with the apparatus which I now consider to represent the best embodiments thereof, but I desire to have it understood that the apparatus disclosed is only illustrative and that the invention can be carried out by other means. Also, while it is designed to use the various features and elements in the combinations and relations described, some of these may be altered and others omitted and some of the features of each modification may be embodied in the others without interfering with the more general results outlined, and the invention extends to such use.

I claim—

1. In a machine of the character described, in combination with means for feeding record cards, means to analyze the cards by causing electric current to flow through holes in the cards while the cards are in motion, and means to control the operation of the machine on the passage of a card having any desired combination of holes in a plurality of columns, any of which columns may have more than one hole; said analyzing means comprising electric contact devices normally out of contact with the card but movable into contact therewith.

2. In a machine of the character described, in combination with means for feeding record cards, means to analyze cards by causing electric current to flow through holes in the cards while the cards are in motion, and means to control the operation of the machine on the passage of a card having any desired combination of holes in a plurality of columns; said analyzing means comprising electric contact devices carried on plug-boards, at least one of said plug-boards being movable to bring the contact devices into contact with the card.

3. In a machine of the character described, in combination with means for feeding record cards to a card conveyor, means to analyze the cards while they are in motion, and means to control the operation of the machine on the passage of a card having any desired combination of holes in a plurality of columns, any of which columns may have more than one hole; said analyzing means comprising electric contact devices normally out of contact with the card but movable in synchronism with said conveyor to contact with the card while it is passing through the conveyor.

4. In a machine of the character described, in combination with means for feeding record cards, a control circuit normally open, means to analyze cards by causing electric current to flow through hole in the cards while the cards are in motion, and magnetic means controlled by said analyzing means to control the operation of the machine on the passage of a card having any desired combination of holes in a plurality of columns, any of which columns may have more than one hole: said analyzing means comprising contact devices normally out of contact with the card but movable into contact therewith to close said control circuit whenever the card has the proper combination of holes.

5. In a machine of the character described, in combination with means for feeding record cards, a control circuit normally open, means to analyze cards by causing electric current to flow through holes in the cards while the cards are in motion, and magnetic means to segregate in one run cards having any desired combination of holes in a plurality of columns, any of which columns may have more than one hole: said analyzing means comprising a plurality of contact devices normally out of contact with the card but movable simultaneously from both sides of the card into contact therewith to close said control circuit through the contact devices when, and only when, the desired combination of holes is in the card.

6. In a machine of the character described, in combination with means for feeding record cards, a control circuit normally open, means to analyze cards by causing electric current to flow through holes in the cards while the cards are in motion, and magnetic means to segregate in one run cards having any desired combination of holes in a plurality of columns, any of which columns may have more than one hole; said analyzing means comprising a plurality of contact devices normally out of contact with the card but movable into contact therewith to close said control circuit through the contact devices when, and only when, the desired combination of holes is in the card, and said segregating means comprising a magnetically controlled card deflector operable whenever said control circuit is closed.

7. In a machine of the character described, in combination with means for feeding record cards, a control circuit normally open, means to analyze cards by causing electric current to flow through holes in the cards while the cards are in motion, and magnetic means controlled by said analyzing means to control the operation of the machine on the passage of a card having any desired combination of holes in a plurality of columns, any of which columns may have more than one hole; said analyzing means comprising a pair of plug-boards between which the card passes, said plug-boards carrying contact devices normally out of contact with the card, the plug-boards being movable in synchronism with the card travel to bring said contact devices against both sides of the card once during every card cycle and thereby complete the control circuit through the card whenever the desired combination of holes is in the card.

8. In a machine of the character described, in combination with means for feeding record cards to a card conveyor, means to analyze the cards while they are in motion, and means to control the operation of the machine on the passage of a card having any desired combination of holes in a plurality of columns; said analyzing means comprising a rear set of parallel metallic insulated bars, one for each card column of index positions, a front set of parallel nonconducting bars, one for each card column, the front set of bars each carrying a plurality of settable contact devices, suitably wired together, said front and rear sets of bars being movable in synchronism with said card conveyor to bring the contact devices against the card once during every card cycle and thereby complete the control circuit by contacting with the rear bars through the card perforations whenever the proper combination of holes is in the card.

9. In a machine of the character described, in combination with means for feeding record cards, a control circuit normally open, means to analyze cards while they are in motion, and means to control the operation of the machine on the passage of a card having any desired combination of holes in a plurality of columns; said analyzing means comprising a plurality of electric contact devices carried on plug-boards and located thereon to register with index positions on the cards, said plug-boards being movable to bring the contact devices into contact with the corresponding index positions on the

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The Creed High Speed Morse Printing Telegraph System

By F. G. CREED

Chairman, Creed Company, Limited

AT THE end of the nineteenth century, seventy years or more after the invention of the electric telegraph, but little progress had been made in the development of Printing Telegraphs. The position in Europe at about that time was that the Hughes, the Stock Ticker and the Baudot Systems were in use on some of the more important circuits in several countries, but the Morse Telegraph was by far the most extensively used System. In Great Britain, the Baudot and Hughes were employed principally for Continental circuits: but the Stock Ticker, for the distribution of market and other news, could be found in all the large cities of the Kingdom. The busiest commercial circuits, and all the more important news circuits of the Post Office, were operated by means of the Wheatstone System, and in addition, a great many Morse duplex and Morse quadruplex systems were employed in handling traffic between larger towns.

The provincial newspapers were nearly all served through the British Post Office by a special organisation based on the Wheatstone System. News gathered in London by the Press Agencies was dealt with in a special section of the Central Telegraph Office, where it was first punched up on the Wheatstone tape by means of a special arrangement of Wheatstone Perforators which enabled a single operator to perforate simultaneously any number of tapes from one to sixteen. The tapes thus prepared were then run through groups of transmitters by means of which the news was distributed simultaneously to provincial towns, where it was written up by hand and delivered by messengers to the newspapers entitled to receive it. In some cases as many as one hundred newspapers in fifty or more towns would receive a news item thus distributed from the common centre.

For the reception of this news at the provincial stations, a staff of nine men (one key clerk and eight writers) was usually provided, the duty of the key clerk being to supervise the line and terminal apparatus, to distribute the Wheatstone tape to the writers, and to ask for and obtain repetitions. Usually several stations would be connected to one line, called a "YQ" circuit, and the normal speed of working was 200 words or more per minute.

In addition to the Post Office News Services a number of the provincial newspapers had private lines to their London Offices in Fleet Street, and the busier of these lines were generally worked by Wheatstone—some of them at very high speeds. A Glasgow newspaper for many years maintained a normal speed of 400 words per minute, although the traffic load seldom exceeded 6,000 words per hour, or an average rate of 100 words per minute. Such high speeds led to an excessive number of RQ's (repeats), and probably did more than anything else to prevent wider use of the Wheatstone System, and to encourage the development of the less speedy but more efficiently operated Printing Telegraph Systems since introduced.

The Early Keyboard Perforator

In 1897 the writer came to England with the object of developing a Keyboard Perforator for use in connection with the Wheatstone System. He had had some experience in telegraphy in the Western Union, and the Central and South American Telegraph Companies, and hoped, by the introduction of a Keyboard Perforator, to save much of the labour involved in the preparation of the Wheatstone tape. After years of hard work and financial stringency, he, and later, Mr. Gell, produced a satisfactory machine.

The first Creed Perforator was not unnaturally of a somewhat crude, if efficient, design. It was operated by compressed air. A keyboard was provided, coöperating with a group of punches, an air-operated hammer and distance pieces adapted to be inserted between the hammer and the punches by a selecting mechanism under the control of the keys, and an air-operated feed mechanism, Figure 1. This instrument could perforate and feed from one to four tapes at a time, and was on the whole a satisfactory machine, its chief drawbacks being the noise produced, and the necessity of providing air-compressing plant.

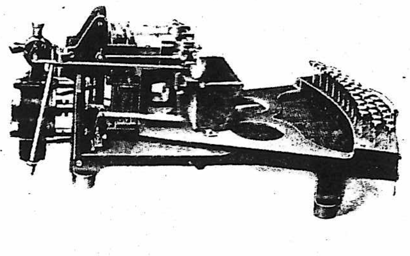


Figure 1—Early Keyboard Perforator.

The Early Receiving Reperforator

Attention was next directed to the receiving end of the Wheatstone circuit, with the object of providing an automatic means of printing the messages in Roman characters as fast as they were received over the line. This was not an easy task. On consideration of the problem of printing from the Morse code, it is evident that the principal difficulty lies in the fact that the Morse letters are of unequal length, and that the shortest and most frequent letter "e" is, in point of time, very short indeed. For instance, when operating at a speed of only 100 words per minute, the letter "e," together with its following space signal, only occupies one-twentieth of a second in transmission. No mechanism existed at that time, nor does it exist at present, which enables a type to be selected from a group, printed on a tape or page, and everything returned to normal in such a short space of time.

The problem of direct printing from Morse signals *at high speed* has not yet been solved. Confronted with this difficulty, the problem was attacked in another way. If the dots and dashes as represented by perforations in the Wheatstone tape, could be reproduced in the same form at the receiving end of the line, the reperforated tape thus received could perhaps be used to actuate a typewriter or similar mechanism operating at a speed lower than that of the line. Such a solution would involve the invention of two machines instead of one, and would cost a great deal of time and expense, but it seemed to be the only way out of the difficulty, and so the development was undertaken along these lines.

After a year or more, a Receiving Perforator (Figure 2) was finally developed which was sufficiently fast and reliable for most commercial purposes. In this instrument compressed air was again employed. A Standard Post Office Line Relay was used to control a Power Relay in a local circuit. The Power Relay in turn moved the tiny piston valve of a small compressed air engine. The reciprocations of this little engine, under the control of the Line Relay, actuated a pair of punches which perforated the corresponding holes in a blank tape drawn through the machine by means of a feed wheel mounted on a frictionally-driven spindle. A wedge inserted at the moment of punching, between the teeth of a saw-tooth wheel on the feed spindle, brought the tape into the correct position and held it there during the operation of punching, so that the holes made by the punches always came directly opposite to the corresponding feed holes on the tape. This simple method of correction for speed variation

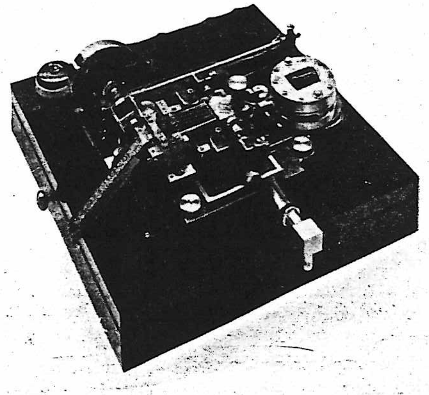


Figure 2—Air Type-Reperforator.

between the transmitter and receiver proved very satisfactory, and was capable of dealing with speed differences as between transmitter and receiver of not less than 15% up or down. Operating speeds up to 150 words per minute were quickly obtained, and the commercial exploitation of the apparatus was begun. It was soon evident, however, that although the machine was able to do as much work as several operators, it would have very little vogue because there were comparatively few cases where such reperforating, apart from any printing operation, was necessary; but at last an application was found for the Reperforator in Manchester, where a certain class of news was received daily for retransmission to Northern towns.

The usual procedure was to provide a staff of nine operators, one to supervise the receiver, and the other eight to write the messages from the Wheatstone tape, at the same time making copies for local newspapers. Another group of eight operators then perforated the messages for retransmission over the YQ lines to Glasgow, Edinburgh and other cities. The introduction of the Receiving Reperforator made it unnecessary to employ these eight operators for reperforating purposes, and thus secured important savings in time and operating costs.

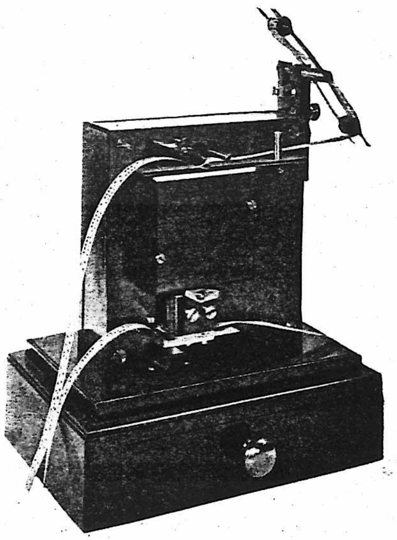


Figure 3—The Cable Translator.

Another field for the apparatus was found at Fredericia in Denmark, where messages passing over the Great Northern Telegraph Company's lines between England, Russia and Scandinavian countries were perforated for retransmission. No other applications could be found for the Reperforator alone, except at the cable station of the Anglo-American Telegraph Company on Valencia Island. At this Station messages were received by Wheatstone from London and Liverpool, and then reperforated in cable code for transmission over the submarine cables. Before the Receiving Reperforator could be introduced at this station, it was necessary to devise some means of causing the Wheatstone Morse signals to perforate Cable Code, or of causing the perforated Wheatstone tape from the Receiving Reperforator to control another machine in which a Cable Code tape would be perforated.

The latter alternative was adopted, and a satisfactory machine was designed for the purpose. This was known as a Cable Translator, Figure 3. By the use of the Receiving Perforator and the Cable Translator, it was found possible, under the control of one Transmitter in London or Liverpool, to produce enough Cable Code tape at Valencia to keep three Trans-Atlantic cables fully occupied. Some years later, the Eastern Telegraph Company employed the Receiving Reperforator for automatic retransmission at certain intermediate stations between England and South Africa, Australia, South America and the Far East, but at the time the Valencia Station was equipped in 1900/1904 there seemed to be no further applications for the apparatus, and the writer was driven, by the necessities of the case, to invent a Printer in order to complete his Morse Printing Telegraph System, and thereby to open the doors of the whole telegraph world to his inventions.

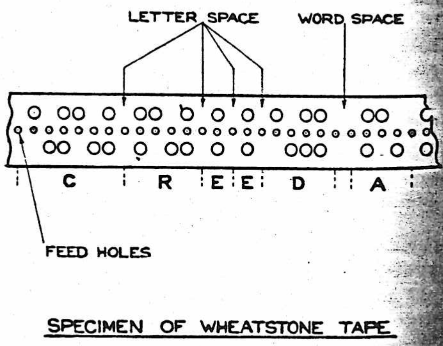


Figure 4—Specimen of Wheatstone Tape.

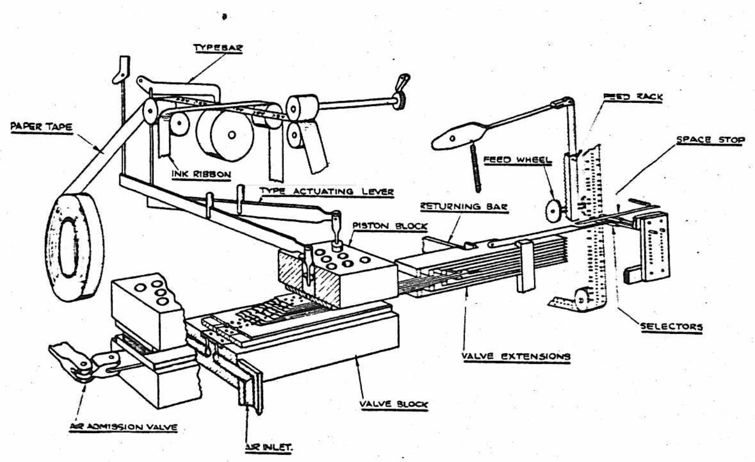


Figure 5—Principle of Printer Selecting Mechanism.

The Early Morse Printer

The invention of a machine to print from the Wheatstone tape was by no means an easy task. Obviously it was necessary to provide a sufficient number of selective elements to deal with the longest or shortest character at one operation. The longest character, the figure 0, contains eleven spaces along the tape. The shortest character contains two spaces, and in addition, there is the space itself, so that it was essential to be able to deal with characters containing any number of spaces from one to eleven. These lengths of tape must not only be "read" but also "fed." It would be easy to read any particular character provided that, like the figure "0" or the apostrophe, it filled out the whole eleven spaces; but when several short characters, as, for instance, the letters of the word "the," all came within the space occupied by the selective group, how were the selectors in that group to know where each letter began and ended, and how could they deal with only one letter at a time, and pay no attention, until the right moment arrived, to the letters following? The solution of the problem of "reading" was to be found in the "feed." If means could be found to feed forward only one letter at a time, and no more, it might be hoped by the same mechanism to find a means of "reading" that letter, and of shutting out the unwanted residue. The solution, when found, was so simple that it is surprising someone had not stumbled upon it before. The secret lay in the fact that while the holes representing dots and dashes in the Wheatstone tape may be perforated on either or both sides of the central row of feed holes, there is always at least one such perforation opposite each feed hole throughout the length of any particular letter; and the double blank, which is a feed hole perforation with blank tape on both sides of it, only occurs when a space is indicated, as in Figure 4.

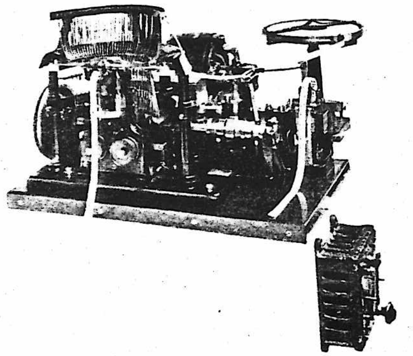


Figure 6—Creed Air Type-Printer.

Having observed this, it was only necessary for the Inventor to provide selective mechanism of a kind in which any selector, entering a hole in a tape, pushed a stop out of the track of a feed bar. The selectors being arranged in pairs, either one or both of each pair would go through the tape for every part of a letter, and would push the space stop out of position, and at the end of the letter the double blank of the space would prevent both the selectors from acting, so that the corresponding space stop would remain in position, and limit the exploring movement of the spacebar, (Figure 5).

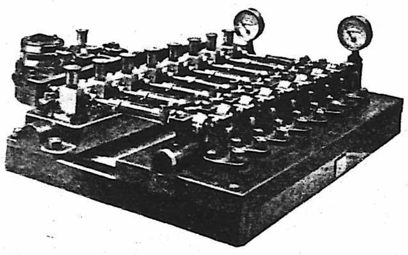


Figure 7—Creed Wireless Key (250 KW).

When this means of determining the length of a letter on the tape had been discovered, it was comparatively easy to develop a feed mechanism that would feed forward the letter being dealt with, and that would bring the next letter up into position to be read at the next operation, and also to provide a shutter mechanism that would render inoperative selectors which might be dealing with perforations beyond the space occupied by the letter being translated. It was afterwards found that the use of a shutter was unnecessary, as the effect of the unwanted combinations could be eliminated by cutting away the corresponding parts of the type selecting combs which were set up by the selectors.

Although a solution in principle had now been found, the task remained of developing a satisfactory Printer. One of the first problems was to decide what kind of printing mechanism should be used; whether to cause the type-operated mechanism to work the keys of a standard typewriter, or to make a special printing mechanism for the purpose. It was at first intended to use a standard typewriter, but finally a special printing mechanism was developed, in which the primary selectors admitted compressed air to little cylinders containing pistons, each of which, when operated, caused the type to strike the paper through a typewriter ribbon. This was found to be an advantageous arrangement, because the little pistons could move any convenient distance, and thus follow the type-bar home, whereas the common striking bar employed by other inventors for operating the keys of a typewriter called for great accuracy in the alignment of the key levers and associated trip-bars.

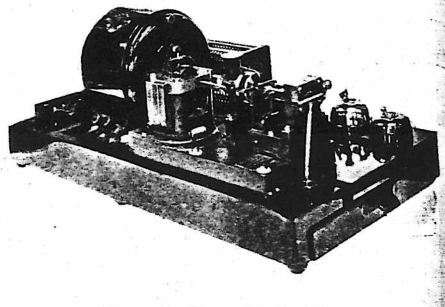


Figure 8—Morse Reperforator.

In the earlier models of this Printer, the compressed air was supplied by the compressor used for the Reperforator, the pressure being regulated by a specially designed reducing valve. Later, however, a small compressor unit was introduced on the Printer itself, actuated by an eccentric on the main shaft (Figure 6). This eccentric was so set that the puff of air was delivered at the correct moment to operate the small piston after its selection. This resulted in considerable simplification of the Printer mechanism, and a reduction in the size of the compressing plant.

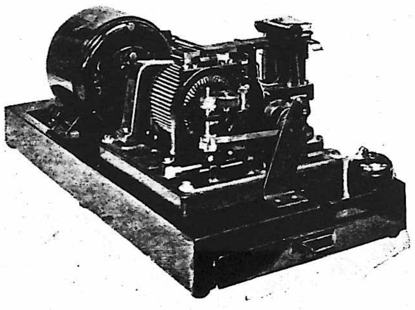


Figure 9—Morse Printer.

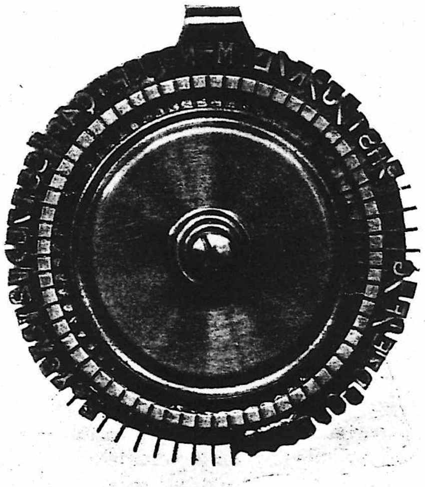


Figure 10—Printer Typehead.

The Reperforator and Printer remained more or less in this form from 1914 until 1919, when it was again possible to devote attention to development. In the meantime, it was found that the Reperforator could be adapted to the control of Radio Stations using Arc transmission, which were very popular at that time. The punches were replaced by large contacts which were arranged to short-circuit a portion of the transmitting inductance. The instrument was controlled by a Wheatstone Transmitter or hand key. Many of the large Radio Stations such as Leafield (Oxford), Cairo and Eiffel Tower, were equipped with these (Figure 7),

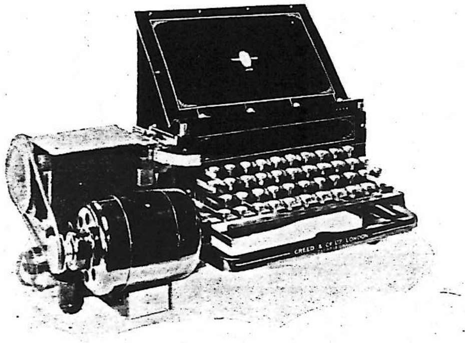


Figure 11—Morse Keyboard Perforator.

The Modern Reperforator

Effort was now directed toward the production of a Reperforator and Printer which would not be pneumatically operated. The necessity for an air compressing plant had always been recognised as a disadvantage; and the improvement effected by the removal of this necessity, in the case of the Printer, served to emphasise the advantages to be gained by its entire elimination.

As the result of two years' investigation and experiment towards this end, the present Reperforator and Printer were evolved, and the first models were put into service in 1921 by the Pacific Cable Board and Commercial Cable Company. Since that date, minor improvements have been introduced, but the general design remains substantially the same.

In the case of the Reperforator (Figure 8) the operation of the punching mechanism is carried out by a cam, frictionally driven, and under the control of a power relay. This control is effected through a simple escapement, which permits the cam to make half a revolution for every movement of the relay tongue. During the half revolution, the corresponding punch is forced through the paper. The method of correction adopted is similar to that used in the older type of machine, except that it is cam-operated. The power for driving the clutch and feeding the tape is derived from a shunt-wound motor, the speed of which is adjusted by means of a variable resistance in series with the field. Apart from the motor and the power relay, the action of the machine is entirely mechanical.

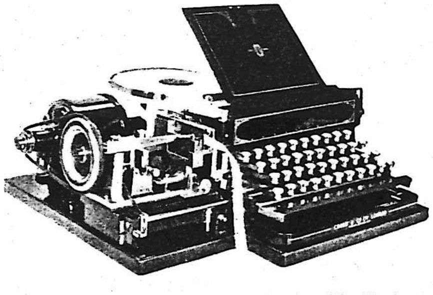


Figure 12—Morse Keyboard Perforator with Horizontal Tape Wheel.

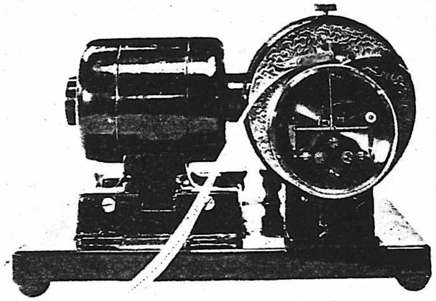


Figure 13—Morse Tape Transmitter.

The Modern Morse Printer

The Printer (Figure 9) also is a motor-driven cam-operated machine, and differs from the pneumatic printer principally in the method of setting up the selection, and the design of the typehead.

The Selectors themselves are very similar to those of the older machine, but in this case a combination disc is provided for each one of the twenty, instead of one for every pair. In this way the unwanted letters which may follow and occupy selectable positions, can be eliminated, by suitably cutting the combination on the discs.

The combinations are notched round the periphery of the discs. Arranged around them concentrically are a number of latches which can be raised and lowered on to the edges of the discs. According to the combination set up, a clear track is left across the twenty discs into which one latch is permitted to drop. It is so arranged that the end of this latch comes into the path of, and arrests, a rotating, frictionally-driven stop, attached to which is the typehead. In this manner the type corresponding to the particular selection set up is brought to rest in front of a hammer, which at the correct moment, presses it forward on to the paper.

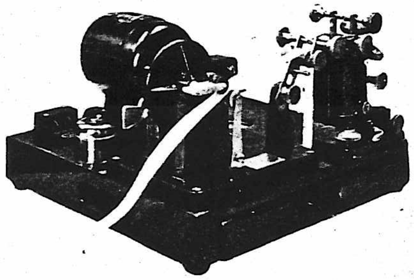
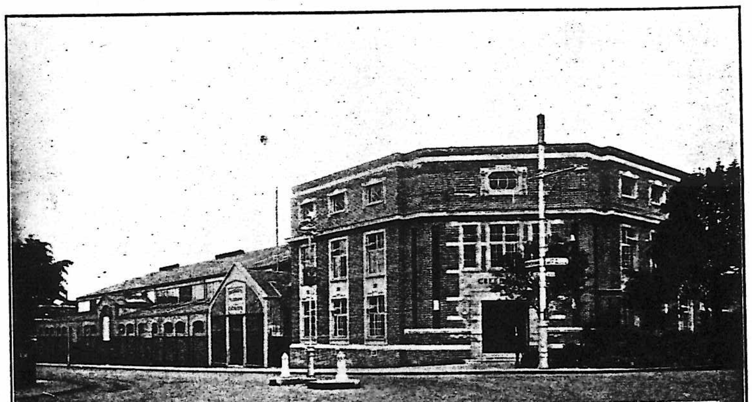


Figure 14—The Creed Undulator.

It was necessary to evolve a typehead of very light yet strong construction, which could be rotated at a high speed, yet stopped and restarted instantly. The weight of this typehead is 23 grammes (Figure 10). Each type is a separate bar, made of steel, hardened, and tempered. These are mounted on an annular pivot, and can be operated independently of each other.

The method of achieving the differential feed of the perforated tape is identical with that used on the pneumatic printer.



Creed Works and Offices.

Portrait of the Author.

The Modern Keyboard Perforator

The High Speed Morse Printing Telegraph System was completed by the provision of a simplified form of Morse Transmitter, Undulator, and improved model Keyboard Perforator, in 1922. The improved model Keyboard Perforator (Figures 11 and 12), avoids the use of compressed air, being cam-operated and motor-driven. The combination bars are arranged so that they can be positively held by the selector bars carrying the operating keys. The punches are supported in a frame, with their heads opposite to the ends of the combination bars. This frame also carries the paper tape, and at the correct time is moved by the cam, forcing the paper against the punches, and the punches against the ends of the combination bars. Those combination bars which are held by the depressed selector bar cause the corresponding punches to be forced through the paper tape. A differential feed mechanism is provided similar to that on the Printer.

The Automatic Tape Transmitter

The development of the secondary cell, and its introduction into telegraph service led to the use of universal batteries with their mid-points earthed. This rendered unnecessary one of the two pairs of contacts included in the design of the Wheatstone Transmitter, and it was obvious that a considerable simplification of the mechanism could be effected by the elimination of these unnecessary contacts. It was to this purpose that the Creed Morse Transmitter was developed.

Further simplification was made possible by the simultaneous development of a polarised relay, one of the special features of which was its very firm contact pressure. By using this relay in conjunction with the transmitter, it became possible to eliminate the jockey retention of the armature. The mechanism of the Transmitter was reduced to two bell-cranks carrying contacts oscillating under the action of an eccentric, and controlled through the usual "peckers" by the tape (Figure 13).

The Undulator

This apparatus (Figure 14) is used where it is required to record incoming telegraph signals in graph form. It embodies the principle of the Kelvin siphon-recorder, and consists essentially of a special type of quick acting galvanometer, and a light siphon tube with one end trailing on a paper tape, and the other end dipping in an inkwell. The paper tape is fed forward by a motor-driven mechanism. A variable gear permits the speed to be adjusted to suit the incoming signals.

The Undulator completes the group of apparatus units used in the High Speed Morse Printing Telegraph system now in widespread use throughout the world.

ERRATA: *Electrical Communication*, Vol. VII, No. 4, April, 1929.

Pages 283 and 289—Schematics of Figures 3 and 5 should be interchanged.

Page 285—In bracket at bottom of column 2, quantity $\frac{1}{2\pi C}$ at right should be separated from rest of the equation by a minus sign, viz., "$-\frac{1}{2\pi C}$."

Page 286—Bracket, column 1. second line, should read:

$$\left[\frac{K}{2\pi C\,[4-3K-\sqrt{(4-3K)^2-K^2}]}-\frac{1}{2\pi C}\right],$$

ELECTRICAL COMMUNICATION

A Journal of Progress in the Telephone, Telegraph and Radio Art

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(3) A Duplex Artificial Line intended to balance the cable circuit, and comprising series and shunt capacities and resistances which are inserted in the circuit by means of push button switches.

The following panels are required for a through repeater circuit:

(a) A Through Telegraph Repeater Panel including two 209-FA relays and two transmitting branches.

(b) A Composite Balance Panel.

(c) Two Duplex Artificial Lines.

An additional Duplex balance panel is required if a by-pass set is installed at the next telephone repeater station.

A terminal repeater bay serves either six complete telegraph repeaters without a monitoring panel or five repeaters with one monitoring panel. For a through repeater bay, the corresponding capacity is four panels for the former and three panels for the latter case. Usually, a monitoring panel is placed on every second bay.

Four-Wire Operation

Although this system has been designed for working on Duplex principles, it is equally adaptable for Simplex working. This method does away with the telegraph balances, but requires four wires to permit telegraph transmission in both directions. The repeater panels are so wired that by means of strapping, they can easily be made suitable for this method of operation. The Simplex method of working may in certain circumstances prove more economical, but it must always be borne in mind that it requires twice as many pairs as the Duplex method described above. Where abnormally long telegraph repeater sections are required it becomes necessary to use the four-wire method of operation, since it is possible to operate circuits of practically unlimited length in this way. Duplex operation cannot be considered reliable for distances exceeding 1000 km.

Non-Composite Working

This system may also be applied satisfactorily to non-composited pairs, either non-loaded or loaded, to which the principal advantages of the system, such as the weak line current, the metallic return and the highly sensitive and stable relays, still apply.

When the system is operated on the non-composited basis the location of telegraph repeaters no longer depends on that of the telephone repeaters. The maximum distance between two successive repeaters may then attain 220 km. for 0.9 mm. leads, and 300 km. for the 1.3 mm. circuits.

Figure 2 illustrates an equipment which was used for demonstration purposes, of two terminal and one intermediate bays. Each bay comprises, in addition to a complete telegraph repeater unit, a monitoring panel, a relay test panel and the necessary composite sets.

Noise

From experiments recently made on 1.3 mm. H-177-63 quad 520 km. long, it was found that the telegraph interference was inherently less than the telephone crosstalk on either of the three telephone circuits when full duplex teleprinter was being maintained on one of the side circuits.

Conclusion

Although the fundamental principles of compositing telephone cables are old, it is only quite recently that the art of compositing small-gauge cable circuits has been brought within the bounds of practicability, without impairing existing high grade telephone service.

In view of the reliability of cable circuits and ease of maintenance of the metallic polar duplex telegraph system, it is possible to envisage an extensive network of composited circuits being built up to meet the requirements of Administrations, bankers, and large industrial concerns with offices and plant located in widely separated parts of the country.

V10 #2 Oct '31

Developments in Start-Stop Telegraphy

The New Creed Printer

DEVELOPMENT of the applications of start-stop printing telegraphy naturally calls for progressive advances in the design of operating equipment in order to meet the more stringent demands which are made upon it. Such modifications in the design of teleprinter apparatus must take into account also economy of production, simplicity of operation, and ease of maintenance.

One of the principal reasons for modification in design is necessitated by the application of teleprinters to telegraph exchange service. In this important new role the teleprinter must fulfill all the conditions which are at present met by the telephone, but with the added advantage of giving transmission by telegraphy.

The new Creed teleprinter is designed to give all these facilities, and its construction, which is arranged on a unit basis, is of great advantage in the field for any unit of the machine in the event of trouble can be readily replaced, and the defective part examined and adjusted at some more convenient time. The removal of a particular unit does not in any way affect the adjustment of other units adjacent to it.

In general the principle of operation remains the same as in earlier types, but in the machine that has been developed for teleprinter exchange service a special device has been incorporated for transmitting back to the calling subscriber the exchange and number of the called subscriber, thus verifying the correctness of the connection. This facility is particularly useful in cases where it is desired to leave messages in the absence of the called subscriber.

The design of the machine has been laid out all in one plane, and all the units come within the limits of the travel of the paper carriage. When all the units are in place and screwed to the base plate all connections are made automatically by means of spring clips, the base plate and wiring forming one of the complete units.

The combined transmitting and receiving teleprinter is shown as a complete unit in Figure 1 and the assembly with the cover removed, in Figure 2. Figure 3 is a rear view of the paper carriage and travelling chariot; Figure 4 illustrates the detailed assembly of all the units of the machine. These units comprise the "answer back" device, cam unit, combination head, ink ribbon unit, keyboard unit, keyboard main base, main shaft, mechanical relay, motor starter unit, operating magnet, paper carriage, printer main base, transmitter unit, typehead, and wiring unit.

In cases where the machine is required for reception only, as in news distribution and ticker services, it is only necessary to undo two screws and remove the keyboard, which is a separate unit connected to the main base.

There is only one high speed shaft in the machine. At one end of this shaft is the motor and, at the other end, the automatic motor starter. At right angles to this shaft and driven from it, are the printing head, the receiving cam shaft, the transmitting cam shaft and the "answer back" shaft.

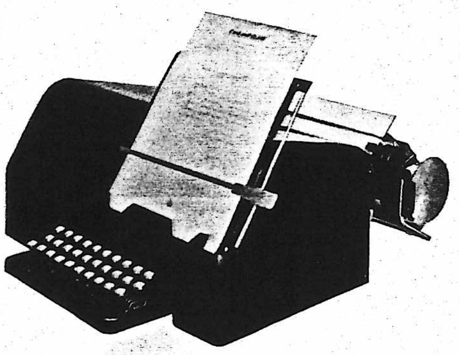


Figure 1—The New Creed Teleprinter—Complete Combined Transmitting and Receiving Unit.

In order to preserve accurate alignment of the printing, the typehead is provided with an outer bearing, and the typehead stop is fitted with an efficient shock absorber. All the shafts on this instrument are mounted in ball bearings, thus making possible the use of a smaller motor. The extensive use of ball bearings has also eliminated the need for frequent lubrication. A detailed view of the keyboard transmitter and receiving units is shown in Figures 5 and 6.

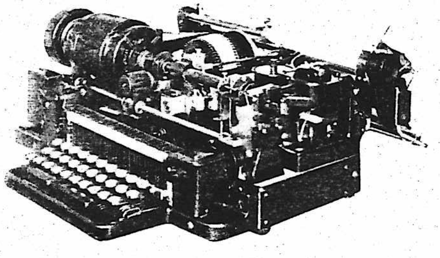


Figure 2—The New Creed Teleprinter With Cover Removed.

General Details of Units

The power of the motor used has been reduced to 40 watts, but it shows an efficiency of 60% at least. Double brushes are provided and, in addition, there is a special fan which ensures that even when the printer is totally enclosed within a specially designed silencing cover, the temperature is always maintained within safe limits.

Both ends of the motor casting are so constructed that they fit tightly in holes in a pair of plates by which they are supported. Electrical connections between the motor and its associated wiring, which is situated under the base of the machine, are made by means of four pins which come into contact with four springs through a hole in the base. These springs are attached to a block on the under-side of which is moulded a series-parallel switching arrangement, so that the connections may be adapted almost at once for using either A. C. series or D. C. shunt motors.

The governor, which is of the centrifugal type, and is totally enclosed in a bakelite case, is mounted on the free end of the motor spindle. And connection is made by means of a pair of brushes which rub on the slip rings.

A useful improvement over previous models lies in the incorporation of typewriter ribbon inking in place of ink rollers, the ribbon being so arranged that it automatically reverses when either reel is unwound.

The paper printing attachment unit comprises the platen carriage which moves from right to left as printing along each line proceeds. The main casting carries the feed and control mechanism, and the paper chariot which carries the paper roll.

The platen carriage is mounted on the main casting by means of a running bar along which slides the grooved portion of the frame, and a keyed spindle which passes through the centre of the platen.

Attached to the carriage is a rack which engages for letter feed purposes with a toothed wheel situated in the main casting. The line feed is accomplished by rotating the keyed shaft which passes through the platen, friction between the keyed spindle and the platen being reduced to a minimum by four rollers which serve as a pair of keyways. The principal components of the carriage are a light casting, a pair of end plates which provide bearings for the platen and a pair of rollers which are fitted on a pivoted axis, and are held in contact with the platen by means of a pair of flat springs.

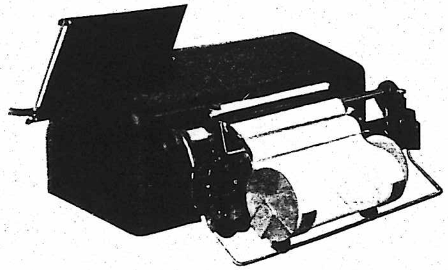


Figure 3—Paper Carriage and Travelling Chariot—Rear View.

Each of the rollers extends practically half the length of the platen in order to give an equal application of pressure throughout the width of the paper. Both the platen and the pressure rollers are rubber-covered.

The mechanism controlling the carriage movements is mounted on the main casting. It consists of the letter feed mechanism, the carriage return mechanism, and the line feed mechanism.

In order to warn the operator of the approaching end of each line the mechanism is so arranged that a line feed bell rings automatically at a point ten characters before the end of the line.

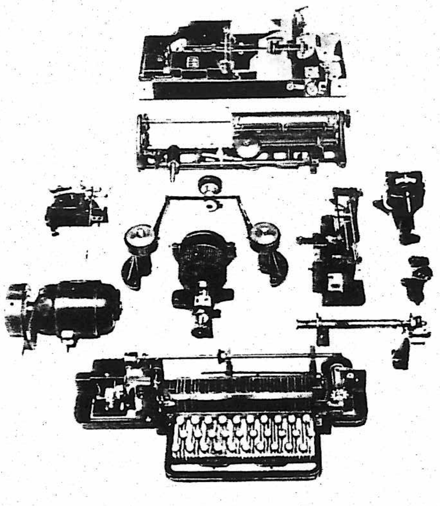


Figure 4—Detailed Assembly of All Units of New Creed Teleprinter.

The bell device is fitted to the page printer attachment.

The teleprinter can be mounted on any table conveniently placed for electricity supply, and requires no special fitting of any kind. The plug socket through which the electrical connections are made may be fastened either to the table or to an adjacent wall.

A special silencing cover, in place of the dust cover normally used, can be fitted on the machine in cases where quiet operation is of considerable importance.

The overall dimensions of the machine with its dust cover in position are: width, 19½ in.; depth, 23½ in.; height 10½ in.

Operating Features

The teleprinter is capable of operation by any typist, at speeds up to 66 words per minute, and it prints on a message roll 8½ in. wide. It utilises a 5-unit code in which the current permutations forming each character are all of equal length. Every signal transmitted is preceded by an impulse which starts the receiving printer, and is followed by an impulse which brings the printer to rest again. In this way it will be seen that the difference in speed between two or more machines is not cumulative, as for each letter transmitted the machines start together. The signalling code used by this machine is shown in Figure 7.

Where more than one copy is required, either carbon backed paper in a continuous roll, or manifold books of separate sheets interleaved with carbon paper, may be used. With the former three good copies can be obtained, and with the latter up to ten copies.

For single current operation, the line current necessary is from 17 to 20 milliamperes, but for double current only 12 to 15 milliamperes is required.

A single transmitting armature is used which ensures that all signals have the same characteristics. The contact pressure is about 50 grammes, and oscillograph records show that there is a complete absence of armature rebound.

On the receiving side a high grade polarized electro-magnet is used so that the new teleprinter can be operated over long distances without the use of an additional line relay. This electro-magnet has two windings connected in series, each having a resistance of approximately 100 ohms.

The teleprinter has been so designed that tape and page printing attachments are interchangeable. Only a momentary interval is required to

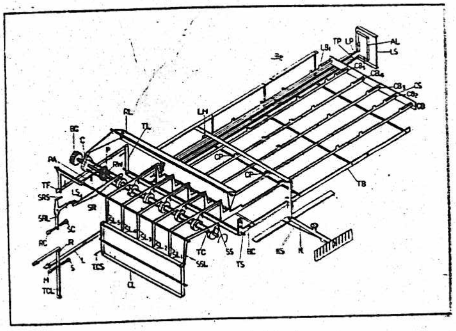


Figure 5—Keyboard Transmitter Unit.

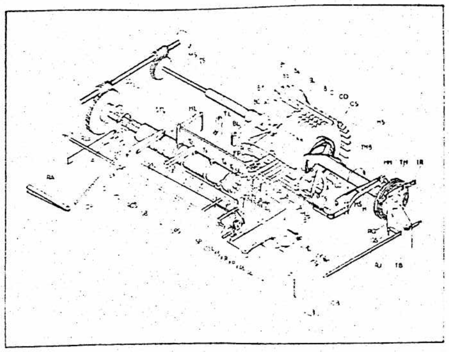


Figure 6—Receiving Unit.

replace one attachment by the other, as a greatly improved form of mounting has been adopted.

Either of the above units can be removed by first operating a latch at one end of the support casting, and then lifting the other end from a vertical stud by which it is supported.

Where telegraph apparatus is operated on a double current simplex basis (transmission in one direction at a time) a send-receive switch is provided for changing over from the sending to the receiving condition, and vice versa. It is impossible for the operator to omit to change back to the receiving condition after the conclusion of transmission, as the switch is incorporated in the transmitter unit, and is entirely automatic in operation.

As the teleprinter may be left unattended for considerable intervals of time, some means must be provided for stopping the machine after transmission has ceased. To effect this it is fitted with an automatic starting switch which closes the motor circuit immediately the printer electromagnet is operated. If no signal is received for a period of two minutes the switch automatically breaks the motor circuit again. The motor is thus kept at rest except during the periods in which signals are actually being received.

To meet the requirements of teleprinter exchange services, the instrument is equipped with the previously referred to "answer back" mechanism which has not hitherto been provided in any other printing telegraph apparatus. On depressing a key on the teleprinter keyboard marked "Who are you?" a special signal combination is transmitted over the line, causing the "answer back" device on the "called" subscriber's machine to repeat back its exchange and number to the "calling" subscriber.

Principles of Operation

Every character is allotted a combination of five units as shown on the code chart in Figure 7, the black circle representing current intervals and the white circles no current intervals. This combination for each individual letter is passed between the transmitter and the printer.

When a key is depressed it engages a clutch, to which is coupled a series of cams which control the sequence of the transmitting operations. Under the control of these cams the depressed key is locked, and all other keys on the keyboard are prevented from moving until the selected character has been transmitted.

START-STOP CODE

A	WHO ARE YOU	○●●○○○●
B	?	○●○○●●●
C	(	○○●●●○●
D		○●○○●○●
E	3	○●○○○○●
F		○●○●●○●
G		○○●○●●●
H		○○○●○●●
I	8	○○●●○○●
J		○●●○●○●
K		○●●●●○●
L	/	○○●○○●●
M	'	○○○●●●●
N	-	○○○●●○●
O	9	○○○○●●●
P	0	○○●●○●●
Q	1	○●●●○●●
R	4	○○●○●○●
S		○●○●○○●
T	5	○○○○○●●
U	7	○●●●○○●
V	)	○○●●●●●
W	2	○●●○○●●
X	£	○●○●●●●
Y	6	○●○●○●●
Z	·	○●○○○●●
	CAR RET	○○○○●○●
	FIGS.	○●●○●●●
	LTRS.	○●●●●●●
	COL	○○●○○○●

SPACE ○○○●○○●

KEY:- ● = MARK
○ = SPACE

Figure 7—Signalling Code.

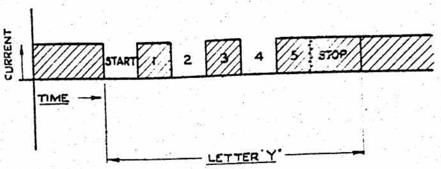
The depression of each key is designed to arrange in a particular manner five bars which are capable of being moved longitudinally, a displaced bar corresponding to a "marking" signal, and a stationary bar to a "spacing signal." Under the control of the cams, each of these bars determines in correct sequence the characteristic of one current unit of the combination transmitted.

In addition to the current impulses forming the particular character combination, two additional impulses are automatically transmitted every time a key is depressed. One of these impulses precedes the character combination and serves to engage a clutch through which the printing selector mechanism is driven; the other, which follows the character combination, causes this clutch to be disengaged after the signal has been translated. A graph of line current for the transmission of the letter "Y," plotted against time for both single and double current working is shown in Figure 8.

The line currents at the receiving end of the line pass through the windings of an electromagnet which turns a shaft into one of two positions for the duration of each signal impulse.

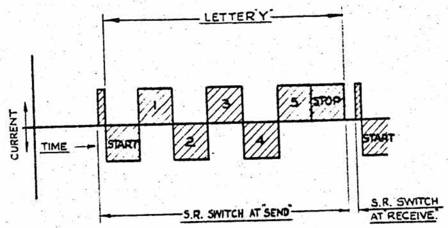
Five small levers are ultimately set backwards or forwards in the same combination as the moving members in the transmitter, this being effected by a synchronised striker which traverses the levers, and is struck forward in front of each lever in succession. The position of the shaft controlled by the electro-magnet determines whether or not the striker will displace the lever, and since the position of this shaft is dependent upon the incoming signal impulse, the character combination selected by the transmitter is accurately reproduced in the printer.

The last stage in the selection of the character to be printed is carried out by an application of the principle of the combination lock, by virtue of which one of a series of radial latches is caused to drop and entirely stop a rotating typehead in such a position that the required type is interposed between a small hammer and the paper. The hammer is operated during the early part of the selection cycle for the next character, and the impression is thus made on the paper.



SINGLE CURRENT CLOSED CIRCUIT

(a)



DOUBLE CURRENT

(b)

Figure 8—Graph of Line Current.

PRINTING MECHANISM FOR CARD CONTROLLED ACCOUNTING MACHINES

Filed June 18, 1928 2 Sheets-Sheet 1

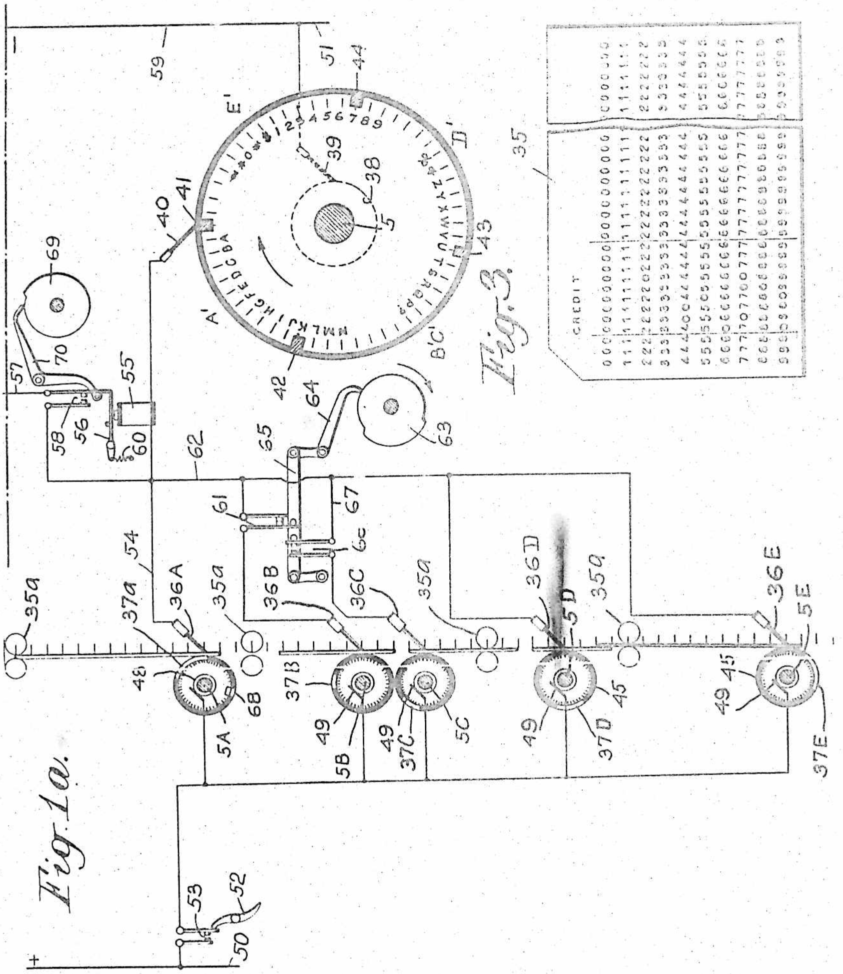


Fig. 1a.

Fig. 3.

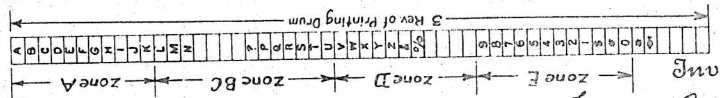


Fig. 2

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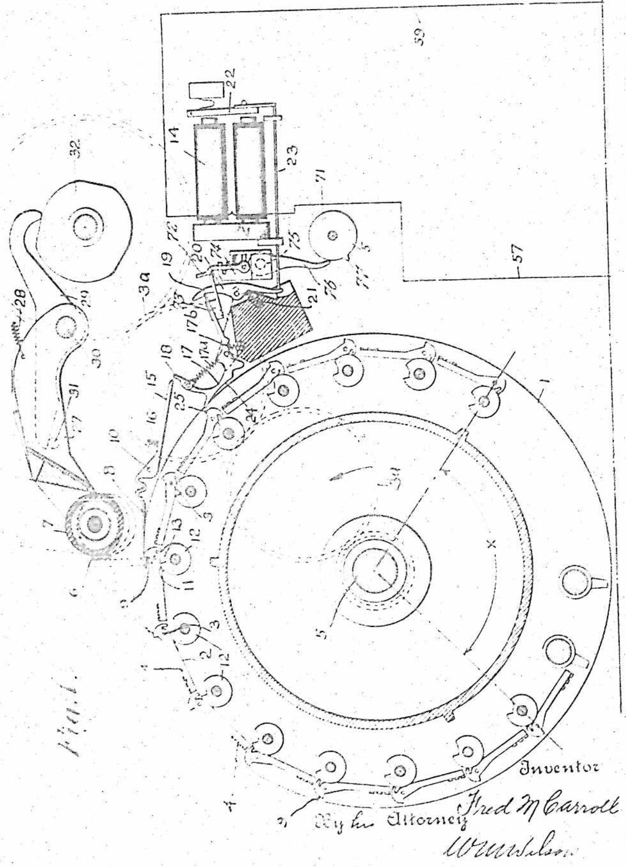
Dec. 8, 1931. F. M. CARROLL 1,835,466

PRINTING MECHANISM FOR CARD CONTROLLED ACCOUNTING MACHINES

Filed June 18, 1928 2 Sheets-Sheet 2



Fred M Carroll
By his Attorney
W.M. Wilson

Patented Dec. 8, 1931 1,835,466

UNITED STATES PATENT OFFICE

FRED M. CARROLL, OF YONKERS, NEW YORK, ASSIGNOR TO THE TABULATING MACHINE COMPANY, OF ENDICOTT, NEW YORK, A CORPORATION OF NEW JERSEY

PRINTING MECHANISM FOR CARD CONTROLLED ACCOUNTING MACHINES

Application filed June 18, 1928. Serial No. [illegible]

This invention relates to accounting machines, such as, for example, a perforated record controlled machine and has for its main object the provision of a machine which will print either numerals, punctuation marks, special identifying characters, or alphabetical characters under the control of perforated records.

In order to avoid the inherent objections of reciprocating printing mechanisms and to cause smooth machine cycles, it has heretofore been proposed in Patents Nos. [illegible] and [illegible] to use a continuously rotating printing drum carrying printing [illegible] which are called into operation as the printing characters successively pass a printing platen. This construction permitted much higher printing speeds than were previously possible but when such a structure was employed for printing alphabetical characters, numerals, etc. it was found that such a drum would be unusually large entailing expense and cost of production and operation difficulties due to its size.

In a prior copending application of F. M. Carroll, Serial No. [illegible] filed April 22, 1927, it was proposed [illegible] printing [illegible] each pivoted type carrier and to cause a relative movement of the platen to select one of the printing characters of a particular [illegible] group. This required three rotations of the drum for a single [illegible] cycle [illegible] printing drum having many advantages over prior structures.

The present invention employs a structure somewhat similar to that disclosed in the prior application but includes in combination therewith an improved form of mechanism which selects the printing characters for operation while the cards are fed into the machine by a continuous uninterrupted motion.

The principal object of the invention then [illegible] is to provide a [illegible] for a [illegible] cyclic [illegible] printing operations [illegible] during a continuous [illegible]

It is another object of the present invention [illegible] with a [illegible] numerical and alphabetical printer [illegible] certain printing characters [illegible] by the combinational [illegible] and others by the single [illegible] system.

It is still another object of the present invention to shift the analyzing function from [illegible] to another during the time that a [illegible] and no printing characters [illegible] operative relationship with the printing platen.

The invention may be clearly understood from the following description which should be read in connection with the accompanying drawings in which the same parts are identified [illegible] throughout [illegible]

Fig. 1 is a sectional view of the printing [illegible] present [illegible] movements are [illegible]

Fig. 2 [illegible] diagram illustrating [illegible] present invention;

Fig. 3 [illegible] the arrangement [illegible] from [illegible] printing [illegible]

Fig. 4 [illegible] of the Hollerith [illegible] present machine.

[illegible] Hollerith card is [illegible] of vertical rows [illegible] usually numbered [illegible] two extra positions known [illegible] The first ten [illegible] a hole punched at one of these index points will, when the card is run through the proper machine, cause a [illegible] value in some form

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usually by printing the digit or by exhibiting the same in counter wheels along with other received digit values.

The present invention uses the standard Hollerith card provided with columns of ten or twelve index points to represent not only the digits, but also the entire alphabet and other arbitrary characters. According to the present system, instead of perforating one hole for selection of certain characters, two holes in a column are punched, which taken together form a combinational hole designation. The first hole, according to its position, serves to designate which of several groups of characters contains the character to be selected, and the second hole designates which of the several characters in the designated group is to be selected. When a single index point is used to select certain other characters that index point is used both to select a group of characters as well as one in that particular group. Mechanism is then brought into operation to print such characters.

In describing the present invention it has been illustrated in connection with mechanisms more specifically disclosed in the Carroll Patent Nos. 1,516,079 dated November 18, 1924, and 1,623,165 dated April 5, 1927.

In Fig. 1 there is shown a circular type carrying drum 1 having a plurality of type carrying bars 2 pivoted at 3. The drum is rotated constantly by a train of gears denoted by 3a and each type carrier carries a plurality of type 4, one below the other, three being the usual number of type on a type bar. The drum is mounted for rotation on a shaft 5 and turns in the direction of the arrow in Fig. 1 so that the type bars pass the printing position in rapid succession. At the printing position are the usual inking ribbon 6 and the platen 7.

Adjacent the type bar in its printing position is a hook member 8 adapted when actuated to move into the path of the hooked portion 9 of the type bar 2 to cause one of the type to be impelled against the ribbon to effect printing. The hook 8 is shown pivoted at 10. Each type carrier is provided with a cam surface 11 with which the cylindrical surface of its locking cam 12 engages. In the printing position of the type carrier 2 a suitable notch 13 of cam 12 is presented to the type carrier to permit it to be rotated about its pivot if it is selected for printing at this time. The type are selected for printing by a call magnet 14. The type carrier is actuated by a printing finger 15 which is one arm of member 8 previously mentioned. The engagement of the hooked end of member 8 with the hook 9 of the type carrier owing to the inertia of the rotating drum 1, forces one of the type on the carrier against the platen as shown in the dotted line position in Fig. 1, to effect printing on a record sheet carried thereby. The finger 15 is normally held out of printing position by a compression spring 16. A pivoted lever 17 has a dog 18 pivoted to one of its arms which normally rests against the tip of the printing finger 15. The dog is free to rotate about its pivot but is urged in a clockwise direction against suitable stops by a spring 17*a*. Another arm of the lever 17 is normally engaged in a notch 19 of a pivoted latch lever 20 the latch lever being urged to latching position by a spring 21. The finger 15 is normally in a non-selecting position and the latch lever 20 in latching position. Energization of magnet 14 attracts its armature 22 and an extension thereon causes a call rod 23 to move to the left in which position the rod 23 rocks the lever 20 against the action of its spring 21 and releases the lever 17, which under action of spring 17*b* rocks counterclockwise causing the dog 18 to snap under the end 15 of the printing finger 8.

Shortly after this the cam surface 24 of lever 17 is engaged by a projection 25 of type carrier 2 behind the one that is to print and the lever 17 is rocked clockwise. The dog 18 being under the printing finger 15 thereupon rocks it against the spring 16 and forces the hook into the path of the extension 9 on the type carrier which is thus called for printing. The camming action between cam surface 24 and the extension 25 continues after the proper type is actually selected for printing and the dog 18 slips from beneath the end of the printing finger 15 whereupon the spring 16 returns the printing finger to normal inoperative position and a latch lever 72 engages the lever 17 and prevents its further operation until the call magnet 14 is again energized during the next card cycle.

The platen 7 is shown in full lines in one printing position and in dotted lines in its other printing positions. As previously stated it is necessary to shift the platen successively to its three printing positions so that when a type carrier is rotated about its pivot the proper type will strike the platen. The mechanism for shifting the platen is illustrated in Fig. 1. The platen 7 is journalled in a pivoted frame 27 normally held by a spring 28 so that the platen assumes the full line position shown. An operating lever 29 pivoted on a shaft 30 supporting the frame 27 has one arm operatively engaging a pin 31 and the other riding on the surface of a cam 32. This cam is connected to the shaft which drives drum 1 and which makes one revolution for every three machine cycles. The cam 32 is provided with three dwells each covering approximately one third of its periphery and each at different radial distances from the center. Normally the lever arm 29 rests on the longest dwell permitting the spring 28 to hold the platen 7 in its uppermost position. The platen remains in its

[illegible] position for one machine cycle, at the end of which the next higher dwell of the cam comes under the arm 29 [illegible] the frame 27 and the platen 7 [illegible] its intermediate position where [illegible] remain for one machine cycle.

At the beginning of the third machine cycle [illegible] the platen [illegible] complete machine cycle. At the end of this cycle the arm 29 rides on the lowest dwell of cam 32 and the operation is repeated. Each position of the platen as seen in Fig. 1 causes a different type on the type carriers to print.

In Fig. 2 the card 35 is shown in the various positions it assumes as it is being fed by the usual feeding rollers 35*a*. The card is fed in this manner past the several sensing stations designated A, B, C, D and E. Each of these stations are provided with the usual Hollerith sensing brushes 36A, 36B, 36C, 36D and 36E adapted to engage the related segments 37A, 37B, 37C, 37D or 37E when a perforation in the card passes between a certain brush and the related segment. Geared to shaft 5 is a series of parallel shafts 5A, 5B, 5C, 5D and 5E. On these shafts are mounted a series of cylindrical commutators 45. In length they are equivalent to the width of a card and the surface of the same may be insulating material in which are embedded the several contact segments 37A, 37B, 37C, 37D and 37E which are also long enough to contact the related series of brushes. The several segments are stepped successively around so that as a particular brush leaves its segment, the brush below will then contact its related segment, the former brush then engaging the insulated portion of its associated commutator. Each cylinder carries a slip ring 48 electrically connected to the related contact segment, and each ring 48 cooperates with a brush 49, the several brushes being electrically connected to one side of a pair of card lever contacts 53.

The spaces between the contact projections 41, 42, 43 and 44 represent separate groups of digit and alphabet characters and these groups are designated A', B' and C', D' and E' inclusive and represent the type carried by the printing bars 2 or the spaces. As shown in Figs. 1 and 2, the latter representing the characters carried by the drum, the sets of type carried by the printing bars are in groups of 14, the group farthest from the pivot of the bars being A—N inclusive, the next group, [illegible] to [illegible] and the third group [illegible] to 0 inclusive.

Current is supplied to the electrical parts of the apparatus by feed lines 50, 51. When the machine operates and the cards begin to feed downwardly the cards reach a card lever [illegible] may be employed or [illegible] in the Patent [illegible] the card is [illegible] of the [illegible] station A [illegible] 36A will [illegible] is passing [illegible] time the brush 36A [illegible] when a perforation at "7" in the card the brush 36A will engage the segment 37A and [illegible] set up as follows: From the supply line 50 [illegible] card contacts 53 [illegible] segment 37A, brush 36A, by a wire [illegible] magnet 55 [illegible] line 51. The relay magnet 55 having become energized attracts its armature 56 which is a lever normally adapted to keep contacts 58 open and which when closed supplies current from the wire 54 by a wire 57 connected to the printing magnet 14. The other side of the magnet is connected by a wire 59 to the negative side of the line 51.

When the armature is attracted it is moved downwardly under the action of spring 60 but the closure of contacts 58 is delayed by the inertia of the armature 56 and the distance travelled thereby before releasing contacts 58 that the circuit to magnet 14 is not completed until about the time the second index point position is in registration with brush 36A, and at this time brush 49 is in contact with the insulated portion of the ring. Obviously any other delayed action may be used to prevent contacts 58 closing in time to permit current to pass through magnet 14 while brush 36A is at the first [illegible] ration.

When a second perforation "[illegible]" in the same column on the card now passes brush 36A of station A the circuit will be completed to magnet 14 as aforesaid. The [illegible] of magnet 14 will actuate armature 22 to release hook 8 to actuate a type bar [illegible] the same against the platen which is shown in its uppermost position due to the low part of cam 32 coacting with lever 29. [illegible] on the diagram when index point "[illegible]" on the card is under the upper brush 36A the character "A" will not have reached the printing line so that, should the second perforation be at index point "[illegible]" the letter "A" will be printed. Similarly if the second perforations are either at "7", "6", "5" or "4", etc., the letters "B", "C", "D", "E", etc., will be printed, since brush 36A will select characters for printing represented by zone "A" in Fig. 2.

Should the first hole in the card be at the point "9" the contact 41 for zone A' will have passed brush 40 and said brush will be on the insulation during the rest of the passage of the card through zone A. Should the first hole be at index point "8", when this point reaches brush 36B of zone B—C the contact point 42 of zone B—C will be in contact with brush 40 and brush 36B will have engaged its segmental contact 37B so that magnet 55 will become energized throwing magnet 14 in readiness for the next hole and should it be "7", "6", or "5", letters "L", "M", or "N" will be printed. At this time the fourteen printing bars will have passed the platen and to render the second group of type active the platen is lowered to its intermediate position by cam 32, this occurring during the angular movement of drum 1 designated by X in Fig. 1.

During the time that brush 36B is sensing holes the circuit to magnet 55 is completed through contacts 61, normally closed, and by wire 62 electrically connected to wire 54. Closing of contacts 61 is permitted by the low part of a cam 63 rotating synchronously with shaft 5.

After sensing of character "N" it will be observed that angular movement of drum 1 represented by X in Fig. 1 occurs and during this time the card is still being fed downwardly so that theoretically, in order that the brush 36B may sense the next hole corresponding to the punctuation mark "(" the brush 36B should move synchronously with the card. In the present instance such movement is obviated by the cam 63 which by its high part shifts a bell crank lever 64 and a bar 65 to close contacts 66 which electrically connect the brush 36C to wire 62 by wire 67. This brush 36C senses the perforations corresponding to characters "(", "P", "Q", "R", "S", "T", "U" which completes zone B—C.

If the first perforation should be at "7" the card will travel downwardly until it reaches brush 36D at which time brush 40 will contact point 43 thus energizing magnet 55. The second perforation following "7" in the same column will cause the selection of any of the characters of zone D. Prior to the selection of characters during the third revolution of the drum 1, cam 32 will again be effective to lower the platen 7 so that the type carried by the printing bars 2 closest to the pivots thereof may be selected for printing. The lowering of platen 7 occurs, of course, during the angular movement of drum 1 designated by X in Fig. 1.

The selection of characters during the first two revolutions of drum 1 is effected by combinational holes but is controlled by single index point designations during the third revolution of the drum.

If a card punched with a single hole such as 9, 8, or 7 in a certain column is fed successively past the stations, A, B—C or D, magnet 55 will be energized as premised hereinbefore to close contacts 58. As the card carrying the single perforation 9, 8 or 7 reaches brush 36E an impulse will be transmitted through closed contacts 58 to magnet 14 since brush 36E will be in electrical contact with segment 37E. This will select for operation the printing bars 2 carrying the type 9, 8 or 7. At a certain point in the revolution of the upper commutator carrying segment plate 37A a special segment 68 will contact brush 36A simultaneous with the contact of brush 40 and contact point 44 thus energizing magnet 55 if the card column carries neither of the single index point perforations 9, 8 or 7. If the card column should have an index point designation at 6 or any index point above on the card, such as 5, 4, 3, 2, 1, 0, 11 or 12, the contact of lowermost brush 36E with such index point designations will transmit an impulse to magnet 14 through previously closed contacts 58 thus selecting the proper printing character for operation.

It will be recognized that after a card has been read and before the next one reaches the reading positions, contacts 58 must be reset to open position. This may be effected by a cam 69 acting at the proper time by a bell crank 70 upon one of the contacts 58 moving it to such a position that it may be subsequently re-latched.

It will be obvious that under certain conditions two type may be selected for printing, when one only is required. To prevent double printing an instance of which may be explained by the following example certain additional mechanism is preferably employed.

The passage of the "9" and "8" index point causes as explained in the preceding, the selection of the "A" character in group "A". Since contacts 58 are retained in latched position, the "9" index point as it passes brushes 36E will cause the selection of the "9" numeral type, causing a double imprint. Under analogous conditions two type may be selected for printing. To prevent such occurrence the following is employed.

As premised hereinbefore when a lever 17 is released it is automatically relatched by a latching pawl 72 which engages an extension 73 of lever 17 and holds it below the notch 19 of the latch lever 20. When so held, any second impulse for magnet 14 during the same card cycle will not release the lever 17. The series of pawls 72 are carried by a frame 74 which is pivoted at 75. Secured to the frame is an actuating arm 76 which is engaged by an extension 77 of a cam 78 mounted on shaft 5 and which is given a single revolution per card cycle. At

the end of a card cycle the series of pawls [illegible] which have been [illegible] so that they may be caught by the [illegible] the latch levers [illegible] to the next type.

As the drum [illegible] revolution cam 32 [illegible] to move platen 7 to its uppermost position.

Printing drum 1 carries special [illegible] characters for printing [illegible] particularly in total taking operations [illegible] since they are not concerned with the present invention they will not be further explained.

The paper feeding mechanism is not disclosed here but may be the same as disclosed in the above mentioned Patent 1,516,079. In this connection it will be remembered that after the third revolution of the drum the paper will be stepped one line space and one card will have been completely read and the data thereon printed. Thus in the present case, the card will be fed through the several sensing positions while the type drum makes three revolutions and the paper feeding will take place after each such revolution. In this way, it will be seen, all of the data taken from a single card will be printed on one line.

While I have shown and described and pointed out the fundamental novel features of the invention as applied to a single modification it will be understood that various omissions and substitutions and changes in the form and details of the device illustrated and in its operation may be made by those skilled in the art without departing from the spirit of the invention. I intend to be limited therefore only as indicated by the scope of the following claims:

1. In a record controlled printing machine, means for continuously feeding record cards through the machine in an uninterrupted motion, means for continuously advancing groups of printing characters to and past a predetermined variable printing point, and analyzing means operable during the uninterrupted motion of said record cards for selecting one of said printing characters in said groups.

2. In a record controlled printing machine, means for continuously feeding record cards through the machine in an uninterrupted motion, means for continuously advancing groups of printing characters to and past a printing platen, means for relatively moving the platen and printing characters to select the groups of printing characters, and analyzing means operable during the uninterrupted motion of said record cards for selecting one of said printing characters in said groups.

3. In a card controlled machine, means for feeding record cards in an uninterrupted motion through the machine, a cyclically operable [illegible] for presenting different groups of type carriers carried thereby to a variable printing point, and analyzing means operable during the continuous uninterrupted motion of the record cards for selecting a type carrier in one of said groups.

4. In a card controlled machine, means for continuously feeding record cards in uninterrupted motion through the machine, [illegible] adapted to be presented to a variable printing point, and analyzing means operable during the continuous uninterrupted motion of the record cards for selecting a type carrier in one of said groups.

5. In a card controlled printing machine, a plurality of groups of type carriers, record-controlled electrically actuated group selecting means, and electrically actuated and record controlled means for selecting a type carrier in one of said groups to present it to a variable printing point.

6. In a card controlled printing machine, a plurality of groups of type, a plurality of card perforation sensing stations, there being a greater number of sensing stations than groups of type and adapted to control the operation thereof to present said type to a shifting variable printing point.

7. In a card controlled printing machine, a plurality of groups of type, a plurality of card perforation sensing stations, there being a greater number of sensing stations than groups of type and adapted to control the operation thereof to present said type to a shifting variable printing point and means for shifting control from one sensing station to another during the shifting of said printing point.

8. In a record card controlled printing machine, a plurality of groups of type adapted to be presented to a variable shifting printing point, and record-controlled analyzing mechanism operable during an uninterrupted motion of the record cards adapted to control the selection of a type of one of said groups.

9. In a record card controlled printing machine, a plurality of groups of type adapted to be presented to a variable shifting printing point, means for shifting the printing point to cause the selection of all the type carriers of one of said groups, and record controlled analyzing mechanism operable during an uninterrupted motion of the record cards adapted to control the selection of a type of one of said groups.

10. In a card controlled printing machine, a plurality of type, a plurality of sensing stations, means for feeding cards in a continuous uninterrupted motion to said sensing stations, each station being responsive to a separate predetermined position on a card, and type actuating means controlled through said stations adapted to bring the selected type to a shifting printing point.

11. In a record card controlled machine,

means for feeding record cards having index point columns through the machine in a continuous uninterrupted motion, groups of data indicating devices common to a card column and an analyzing mechanism responsive to either combinational hole or single hole designations for differentially controlling said indicating devices.

12. In a record card controlled machine, means for feeding record cards having index point columns through the machine in a continuous uninterrupted motion, said cards adapted to represent data by either single or combinational index point designations, groups of data indicating devices common to a single card column, and an analyzing mechanism comprising a plurality of analyzing stations responsive to either single or combinational index point designations for differentially controlling said indicating devices.

13. In a record controlled machine, means for feeding cards to the machine, data indicating devices for representing alphabetical characters or numerals, and an analyzing mechanism responsive to combinational index point designations for selecting alphabetical characters and responsive to single index point designations for selecting any of the numerals of a decimal system.

14. In a record controlled machine, a plurality of groups of type, and a plurality of card controlled group selecting stations and card controlled type selecting means responsive to both combinational and single index point designations.

15. In a record controlled machine, a plurality of groups of type, and a plurality of card controlled group selecting stations and card controlled type selecting means responsive to both combinational and single index point designations adapted to bring one of said type to a variable and shifting printing point.

16. In a card controlled machine, a plurality of groups of type representing alphabetical characters and numerals and an analyzing means responsive to both single and combinational index point designations on record cards fed continuously and uninterruptedly to analyzing means for selecting a type of one of said groups.

17. In a card controlled machine, a plurality of type representing alphabetical characters and numerals, an analyzing means responsive to both single and combinational index point designations, said analyzing means adapted to select for operation numeral type in accordance with single index point designations.

18. In a card controlled machine, a drum carrying a plurality of groups of type representing alphabetical characters and numerals, said drum having cyclic rotations commensurate with the number of groups of type carried thereby, and a plurality of sensing stations adapted to select type of one of said groups during the cyclic rotation of said drum.

19. In a card controlled machine, a drum carrying a plurality of groups of type representing alphabetical characters and numerals, said drum having cyclic rotations commensurate with the number of groups of type carried thereby to bring said groups successively in co-operation with a shifting printing point and a plurality of sensing stations adapted to select type of one of said groups after the shifting of said printing point and during the cyclic rotation of said drum.

20. In a record controlled printing machine, comprising several groups of type adapted to be presented successively to a printing point, and an analyzing means responsive to a single index point in a card for selecting one of the several groups of type and the particular type in the selected group to be presented to the printing point.

21. In a record controlled printing machine, groups of type adapted to be presented successively to a printing point, and an analyzing means responsive to either single or combinational index points for selecting a desired group of type and the particular type in the desired group to be presented to the printing point.

22. In a record controlled machine, means for feeding record cards through the machine in an uninterrupted motion, means for continuously advancing groups of printing characters to and past a platen, means for causing a relative movement between said platen and each group of type to select a group of type for printing, and an analyzing mechanism for selecting a type in the pre-selected group.

23. In a record controlled machine, the combination with a plurality of groups of characters, several groups designating alphabetical printing characters and a single group for designating numerals, means comprising a record card having index points for selecting the desired groups of type, and means whereby the alphabetical groups of printing characters are selected by combinational index points on said record card and the numeral group by single index points.

24. In a record controlled machine, the combination with several groups of type, and an analyzing means responsive to a plurality of index points of a record card for selecting certain of the several groups of type and responsive to a single index point for selecting another group of type.

25. In a record controlled machine, the combination with a plurality of groups of type, and means responsive to a plurality of index points for selecting a group of type and a particular type in a group and responsive to a single index point for selecting another group of type and a particular type in that group.

26. In a record controlled machine, the combination with a plurality of groups of type, and record controlled type selecting means responsive to a plurality of index points for selecting certain groups and a particular type in such group and to a single index point for selecting a type in another group.

In testimony whereof I hereto affix my signature.

FRED M. CARROLL.

1853443

April 12, 1932. M. MAUL 1,853,443

RECORD CARD WITH PRINTED INDEX POINTS

Filed July 1, 1927 4 Sheets-Sheet 1

Fig. 1.

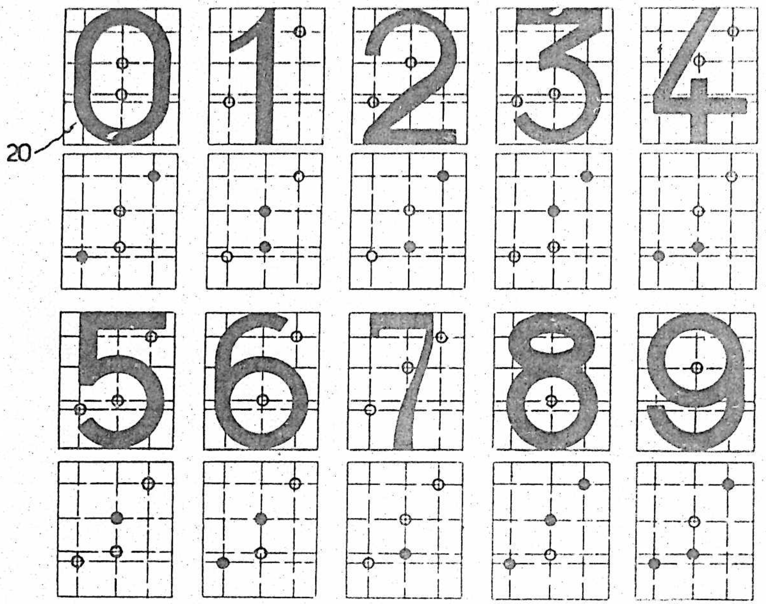


Fig. 2.

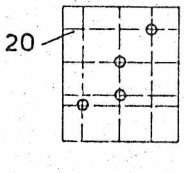


Fig. 5.

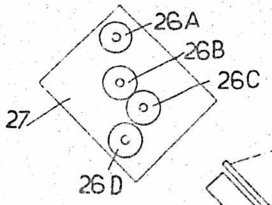


Fig. 4.

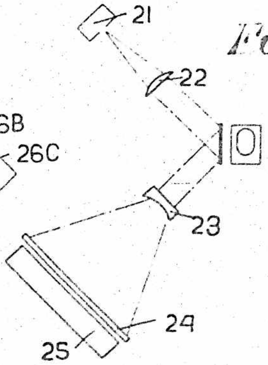
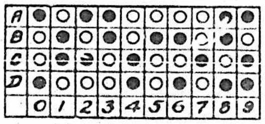


Fig. 3.



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COMBINATIONAL HOLE PUNCH

Filed April 7, 1930 23 Sheets-Sheet 22

FIG. 36.

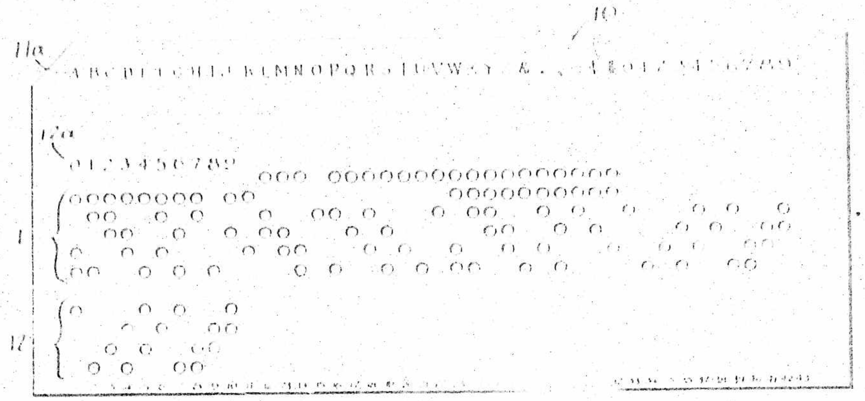
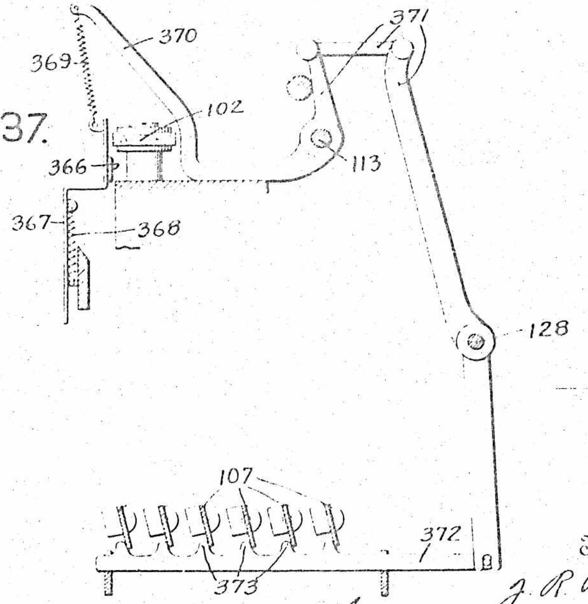


FIG. 37.



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PRINTING MECHANISM

Filed April 9, 1930 8 Sheets-Sheet 8

FIG. 17.

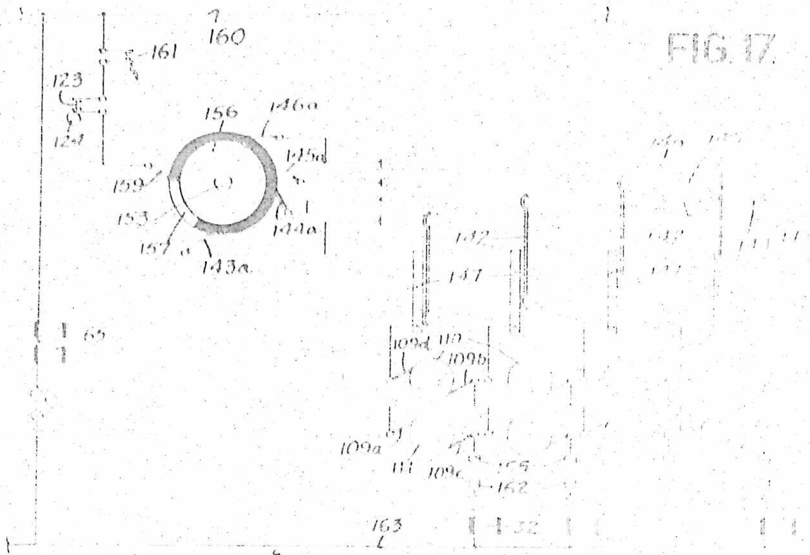


FIG. 16.

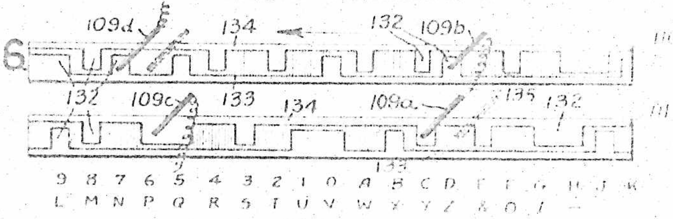
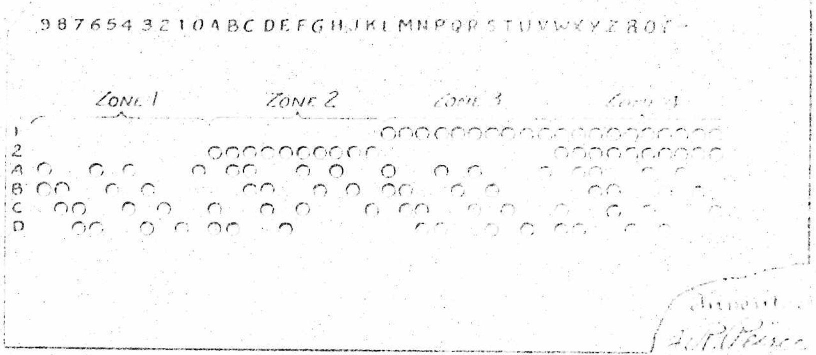

109d
134
132
109b
110
132
109c
133
134
109a
135
132
111
133
9 8 7 6 5 4 3 2 1 0 A B C D E F G H J K
L M N P Q R S T U V W X Y Z & O J

FIG. 15.


9 8 7 6 5 4 3 2 1 0 A B C D E F G H J K L M N P Q R S T U V W X Y Z & O J
ZONE 1
ZONE 2
ZONE 3
ZONE 4
1
2
A
B
C
D

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By his Attorney

Oct. 4, 1932. J. W. BRYCE 1,880,408

ALPHABETICAL CODE PUNCHING DEVICE

Filed March 23, 1925 4 Sheets-Sheet 1

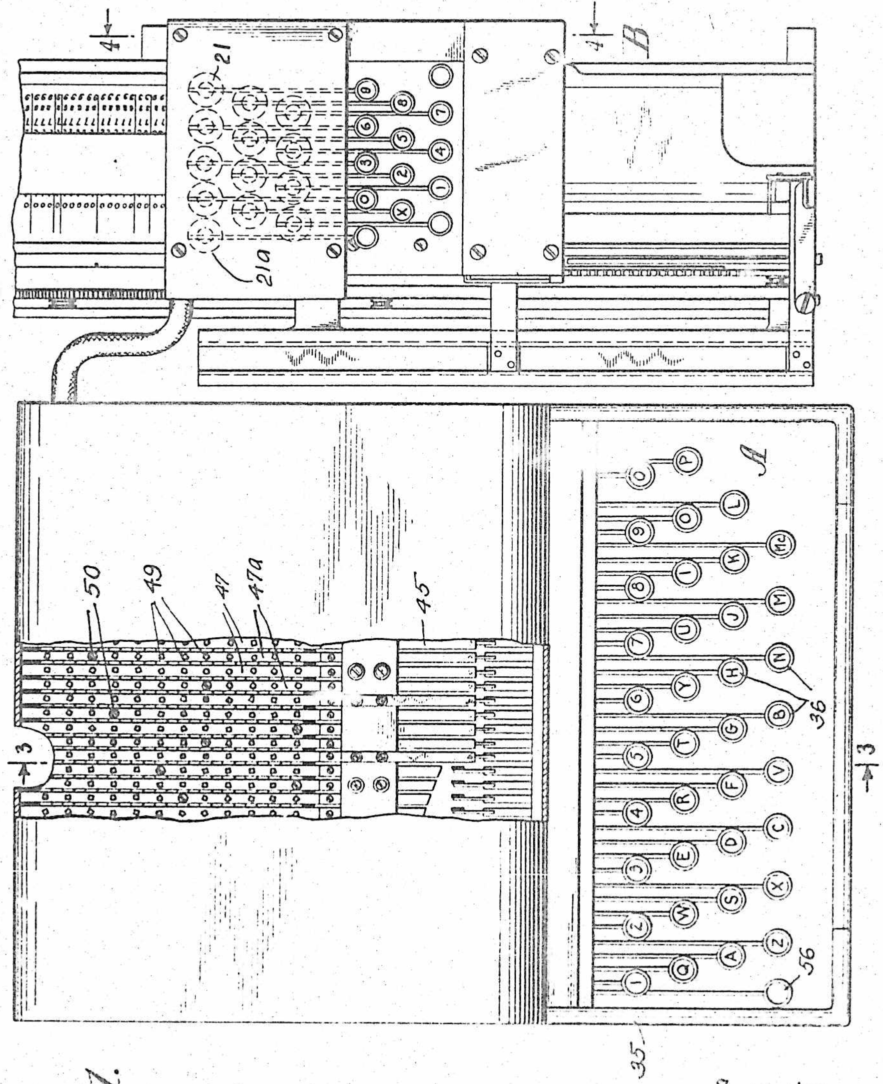

Fig. 1.

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ALPHABETICAL CODE PUNCHING DEVICE

Filed March 23, 1925 4 Sheets-Sheet 2

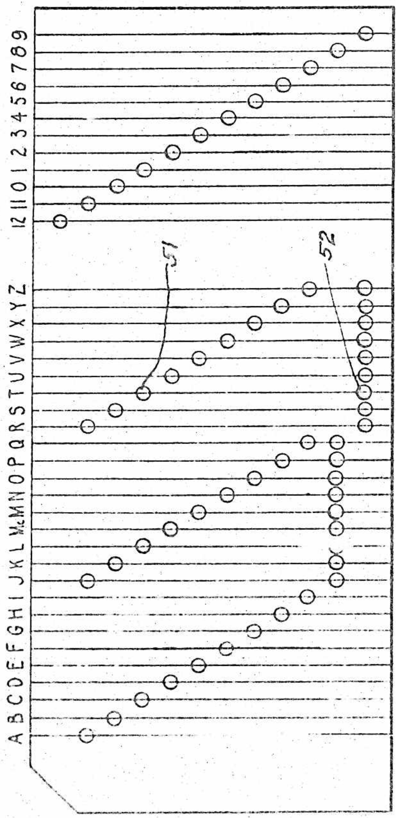

Fig. 2.

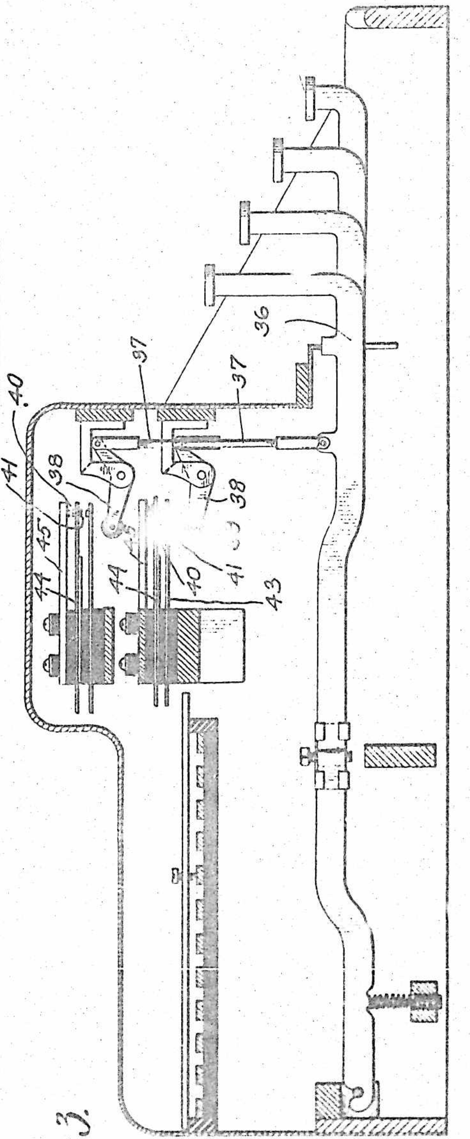

Fig. 3.

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ALPHABETICAL CODE PUNCHING DEVICE

Filed March 23, 1925 4 Sheets-Sheet 3

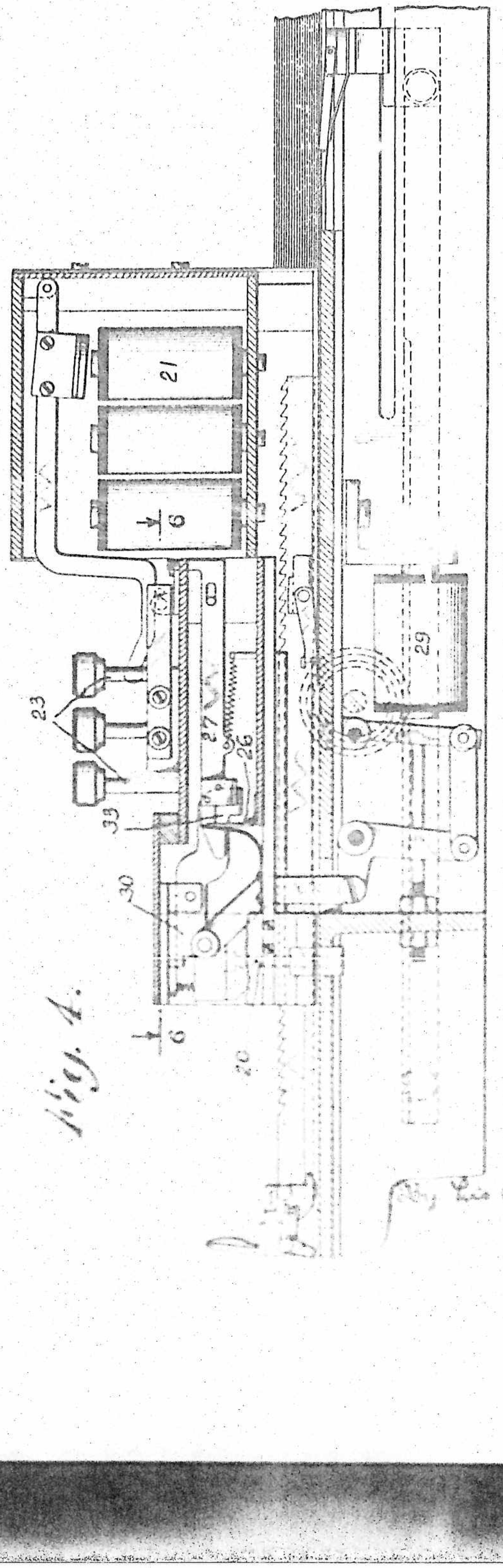

Fig. 4.

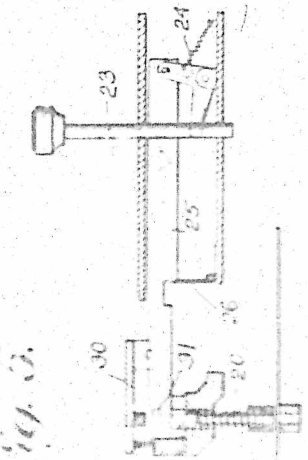

Fig. 5.

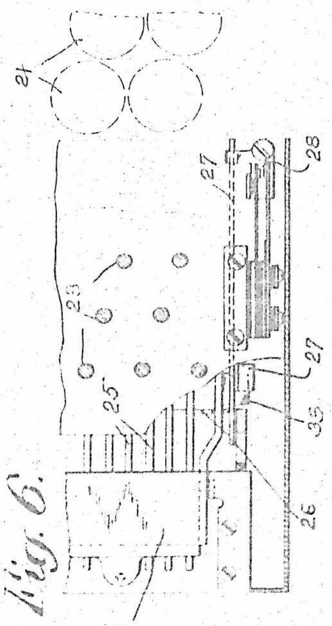

Fig. 6.

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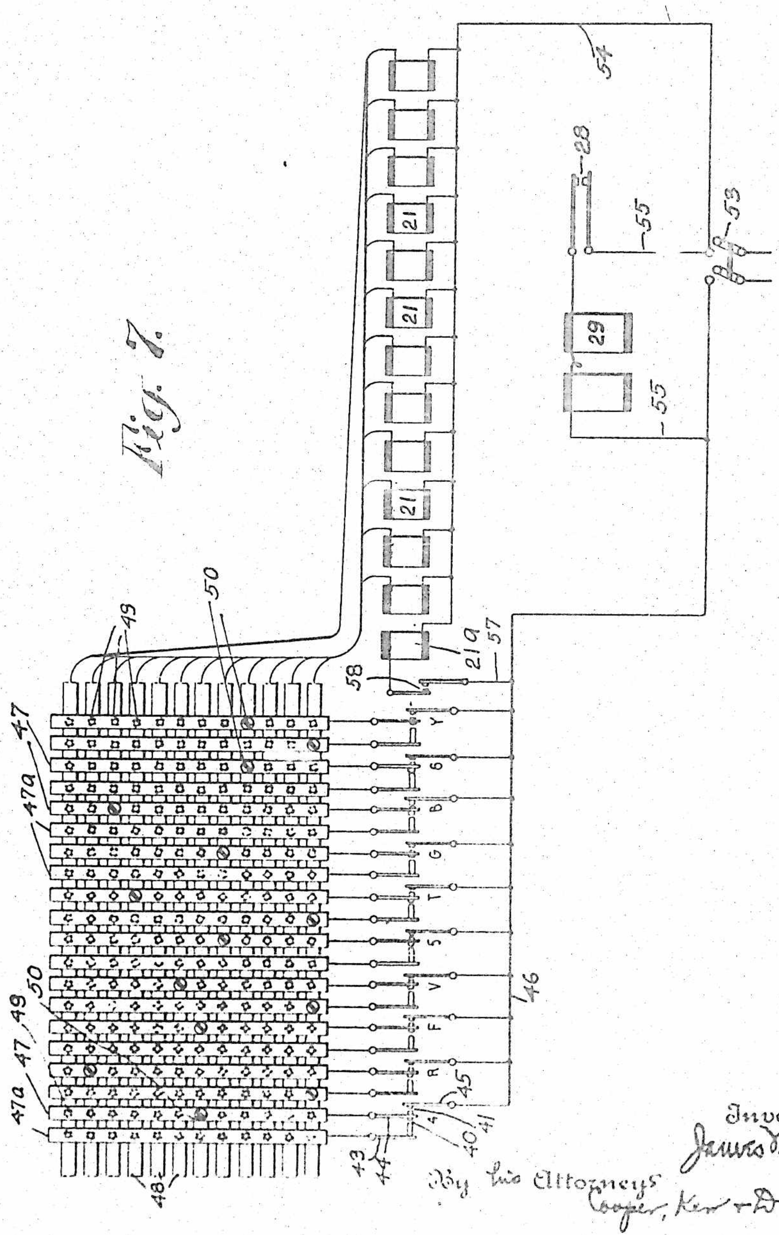
ALPHABETICAL CODE PUNCHING DEVICE

Filed March 23, 1925 4 Sheets-Sheet 4

Fig. 7.



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Patented Oct. 4, 1932 1,880,408

UNITED STATES PATENT OFFICE

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ALPHABETICAL CODE PUNCHING DEVICE

Application filed March 23, 1925. Serial No. 17,685.

The present invention is directed to an improvement in punching devices for punching tabulating cards.

In the making of these cards for directory work it has become the practice to code the alphabet and utilize multiple punchings to denote letter characters. The punching of such coded multiple punched cards with punching devices now in use requires a considerable amount of skill as ordinarily it is necessary for the operator to perform the coding operation mentally and then to strike the proper combination of keys to accord with the coded character. In other devices utilizing combinational holes for denoting alphabetical characters the machine itself effects the coding but the actual punching operation is effected by the power of the operator's fingers.

The present invention is directed to the provision of a simple punching device which is adapted to be controlled by a keyboard similar to that used on typewriting machines and in which the coding of the characters is effected automatically by the machine and in which the direct labor of punching is performed by the machine itself instead of by the operator as heretofore.

According to the present invention the operator strikes the usual typewriter form of keys. The operation of these keys effects the selection of the desired combinations of punches and thereafter the punching operation itself is performed by the power derived from a translating device in the punching attachment. The operator merely depresses the keys for controlling and selecting purposes and all other operations are performed automatically by the machine. According to the present invention the only effort required upon the part of the operator is the effort required to close a single pair of contacts associated with each key and all the other operations are performed automatically and by an outside source of power.

Further objects and advantages of the present invention will be hereinafter set forth in the accompanying specification and claims and shown in the drawings which by way of illustration portray one embodiment of my invention.

In the drawings:

Fig. 1 is a top plan view of the complete apparatus.

Fig. 2 is a view of the card punched by the punching device.

Fig. 3 is a sectional view through the keyboard showing the contact devices, the section being taken on line 3—3 of Fig. 1.

Fig. 4 is a sectional view of the punching attachment, the section being taken on line 4—4 of Fig. 1.

[illegible] an enlarged sectional view of certain parts in the punching attachment in moved position.

Fig. 6 is a top plan view of parts of the punching attachment on an enlarged scale.

Fig. 7 is a circuit diagram of the machine.

The machine in general includes a keyboard section designated A and a punching section designated B. The punching section B in its general characteristics is similar to devices already in use. It consists of the usual electric key punch previously utilized for punching the tabulating cards. The particular form herein used is more fully shown and described in the copending application of John T. Schaaff, Serial No. 731,980, filed August 14, 1924. A somewhat similar form of punching device is shown in the patent of L. C. Reynolds No. 1,[illegible]98,100. The punching attachment includes the usual mechanism for feeding the cards through the machine. The principle of operation utilized with punches of this character is to provide a plurality of punches 20 disposed across the punching attachment, each punch corresponding to a particular index point perforation in the card. In the present embodiment twelve such punches are provided. In the operation of the punching attachment a punching operation is effected upon one column of the card, then the card is displaced relatively to the punches and a second punching operation is performed in another column on the card. The arrangement of the parts is such that feed of the card takes place after each punching operation. The card feed is usually effected by means of a spring

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such as is shown in the Reynolds patent and the feeding action is controlled after each punching operation by suitable escapement mechanism well known in the art.

Within the punching section B there are a plurality of selecting magnets 21, one selecting magnet being provided for each punch. These selecting magnets, when energized, effect the selection of the punches in the following manner.

Referring to Figs. 4 and 5 a selecting magnet 21, when energized, attracts its armature 22 thus depressing a plunger 23 and through bell crank 24 thrusts forward an interposer bar 25 over its corresponding punch 20. The forward movement of any interposer bar is adapted to impart a rocking movement to a bail 26, which bail is suitably connected to a link 27 which extends rearwardly and actuates contacts 28 to close the same. The closure of these contacts establishes a circuit to the main punch actuating magnet 29. This magnet being energized rocks a bail 30 downwardly. Bail 30 is disposed over the interposer bars and the downward movement of this bail will depress any interposer bar or bars which have previously been thrust forward by their corresponding selector magnets and in this way depress the corresponding punches 20 through the card. Only punches correlated to interposer bars which are not thrust forward are not actuated by bail 30 inasmuch as their interposer bars will be in the position shown in Fig. 5. The bars when in this position will present a clearance notch 31 under the bail 30 and permit the depression of the bail without the depression of the corresponding interposer bars. The movement of the bail 30 is also utilized to reopen contacts 28 previously closed by the drawing forward of link 27. For this purpose link 27 is made hook-shaped and is hooked over bail 26. The bail 30 has a bracket portion 33 carried thereby which extends under a projecting foot on link 27. (See Fig. 6.) Upon the elevation of part 33 link 27 is released from bail 26 and is drawn backwardly by means of its spring to permit reopening of contacts 28.

Also disposed in the punching section of the machine there is a magnet 21a which is energized when a spacing operation is to be effected without the effecting of punching. This magnet 21a has the usual interposer bar 25 associated therewith but there is no punch disposed cooperating therewith.

Referring now to the keyboard section of the machine, this section comprises a frame 35 similar to that of a typewriter. Suitably pivoted in the frame are keys 36 similar to typewriter keys. Each key 36 has connected to it a pull rod 37 connected to a bell crank 38 provided with an insulated roller 39. The depression of any key is adapted to close pairs of contacts 40, 41, which are disposed directly above the insulating roller 39. Each contact combination 40, 41, is made up of a lower blade 43, an intermediate blade 44 and an upper blade 45. In the operation, closing of contacts 41 is followed by closing of contacts 40. Referring now to the circuit diagram (Fig. 7) each upper blade 45 is connected to common line 46. Each intermediate blade 44 is connected by a suitable wire to a bus bar 47. Each lower blade 43 is connected to a corresponding bus bar 47a. Bus bars 47 and 47a of which there are a pair for each key and contact combination extend transversely across a series of conductor bars 48 which are individually connected in series to the selector magnets 21. There is accordingly one bar 48 for each selector magnet 21. Bars 47 and 47a are provided with threaded apertures 49 over each bar 48. In these apertures suitable screws 50 can be placed depending upon the particular combination or coding which it is desired to establish.

Referring to the contact combination marked T, for example, it is noted that there are two screws 50 in position. Therefore upon the closing of the contact combination by the T typewriter key the lower connecting bar and the fourth connecting bar from [illegible] top are energized. Thus two selector [illegible]s 21 will be energized concurrently and two punches will be called into operation to punch on the card a nine hole marked 52 and a one hole marked 51. This will effect the proper coded punching for the punching of the symbol T.

It will be understood that the current flows from source 53 through wire 46, through the selected contacts 40, 41, thence through cross bars 48, magnets 21, and back through wire 54 to source. The main punch operating magnet circuit 55 is closed through contacts 28 as previously explained thus bringing about the simultaneous actuation of one or more punches. The cross transposer bars 47, 47a, 48, provide a simple arrangement for changing the coded combinations without rewiring the machine. It will be understood that the typewriter may be provided with the usual space key or special key 56 for effecting spacing, which key can be arranged to close a pair of the contacts to the space magnet 21a. Such space key circuit it will be understood is in no way related to the selector magnet circuit but is an independent circuit shown at 57 and extending through contacts 58 which are closed upon the depression of the space key.

What I claim is:—

1. In an apparatus of the class described, the combination of a series of keys, a series of punches, a set of bus bars, a plurality of which are connected in pairs with each of a few of said keys, and means comprising another set of bus bars intersecting the first mentioned set of bars and connected to said

punches so that different desired combinations of punches may be placed under control of any of the keys.

2. In an apparatus of the character described, the combination of a series of keys, of a plurality of bus bars for each key, a contact for each of the bus bars, said contacts being closed by operations of the associated keys, a plurality of punches, a magnet controlling each of the punches, and means whereby any desired magnet may be connected to any desired bus bar.

3. In an apparatus of the class described, the combination of a series of keys, a series of punches to be operated in code combinations upon operation of the keys, a plurality of bus bars for each of the keys, a bus bar for each of the punches, and means whereby any one of the key bus bars may be connected to any one of the punch bus bars to set up the different combinations of punches to be called into play by selective operation of the keys.

4. In an apparatus of the class described, the combination of a series of keys, a plurality of contacts operated by each of said keys, a series of punches to be brought into operation by the operation of said contacts, and means comprising intersecting bus bars coordinated with said punches and contacts for bringing different combinations of punches under the control of any of the keys.

5. In a punching machine, a plurality of punches, a plurality of connections for effecting actuation of said punches, a plurality of contacts, a key for operating said contacts, and means for associating selected combinations of said connections with said contacts to effect actuation of corresponding combinations of several punches, said means being shiftable relative to said connections to vary the combination of connections associated with said key whereby the same movements of said key may be made to select different punch combinations.

In testimony whereof I hereto affix my signature.

JAMES W. BRYCE.

Oct. 25, 1932. S. MORTON 1,884,807

KEYBOARD MECHANISM FOR TELEGRAPH APPARATUS

Filed April 4, 1930 2 Sheets-Sheet 2

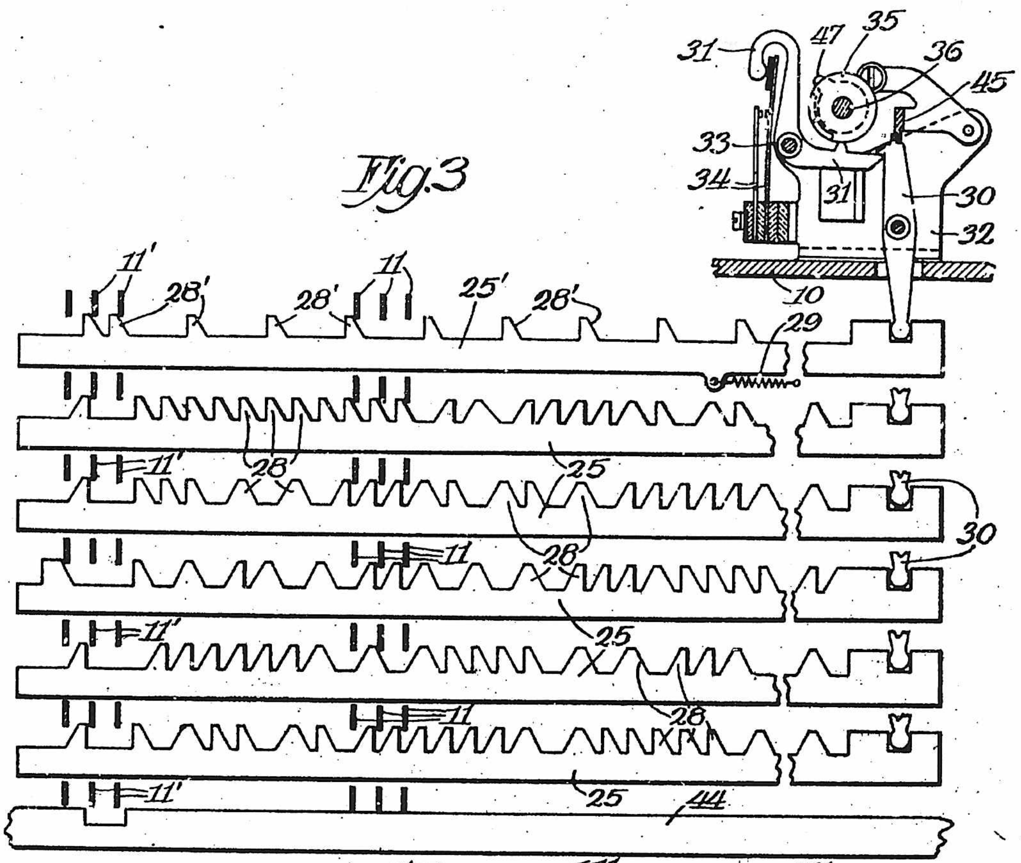

Fig. 3

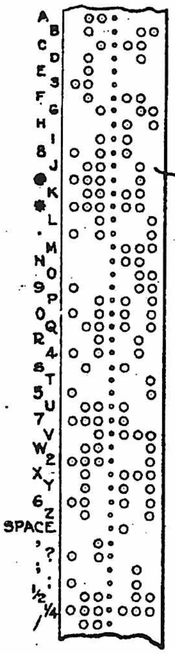

Fig. 6

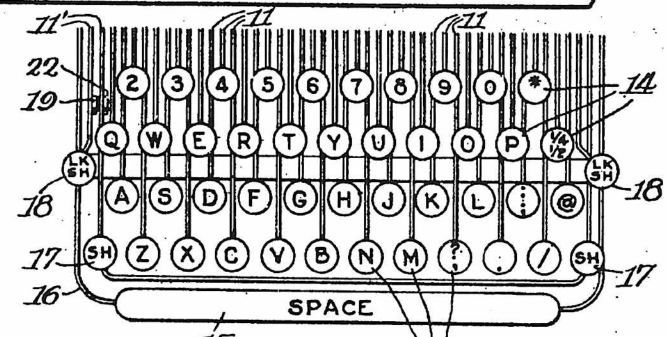

Fig. 4

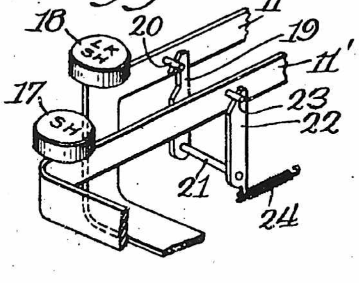

Fig. 5

INVENTOR.

Sterling Morton

BY Fisher, Clapp, Soans & Pond

ATTORNEY.

Feb. 7, 1933. J. R. PEIRCE 1,896,555

ROTARY PRINTING MACHINE

Filed Jan. 14, 1931 4 Sheets-Sheet 4

FIG. 6.

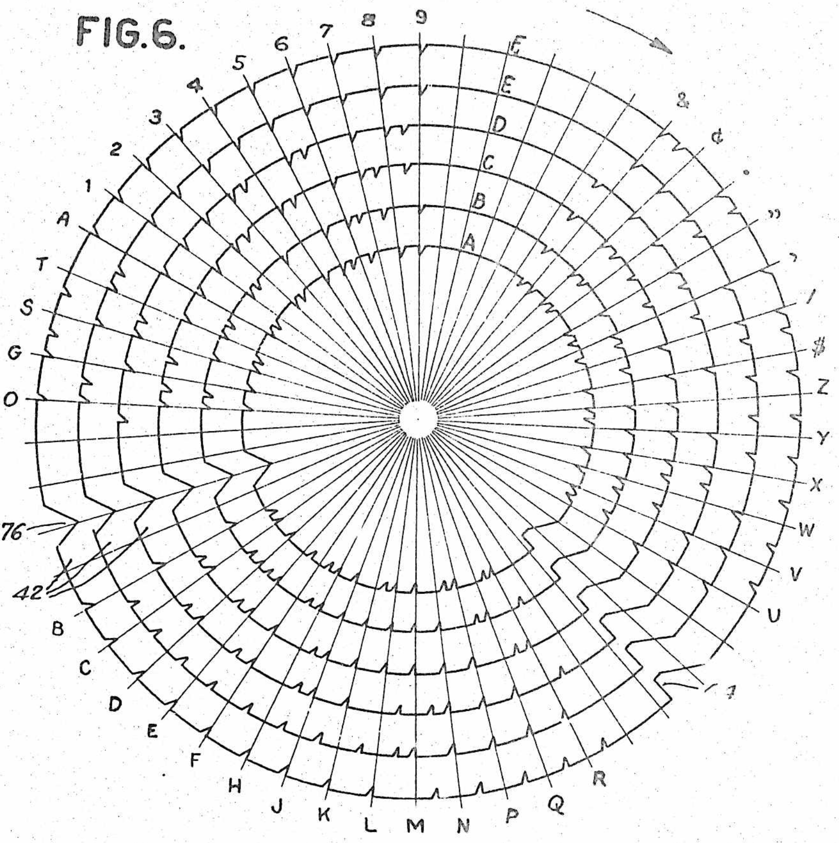

FIG. 7.

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V	W	X	Y	Z	&	.	,	/	¢	$	"	0	1	2	3	4	5	6	7	8	9
F													○	○		○	○	○	○	○	○	○	○	○	○	○					○	○	○										
E	○	○	○	○	○	○	○	○		○	○	○												○	○	○						○	○										
D			○		○			○				○	○		○			○		○			○			○	○		○	○				○				○		○			○
C		○		○			○	○									○		○			○	○				○	○	○				○				○		○			○	○
B	○		○			○	○									○		○			○	○					○	○		○		○				○		○			○	○	
A		○			○	○			○		○			○			○			○	○				○			○	○	○					○		○			○	○		

INVENTOR

J. R. Peirce

BY his ATTORNEY

W. M. Wilson

March 21, 1933. P. DECHENE 1,902,060

PRINTING MECHANISM

Filed Nov. 27. 1929 2 Sheets-Sheet 1

FIG. 1.

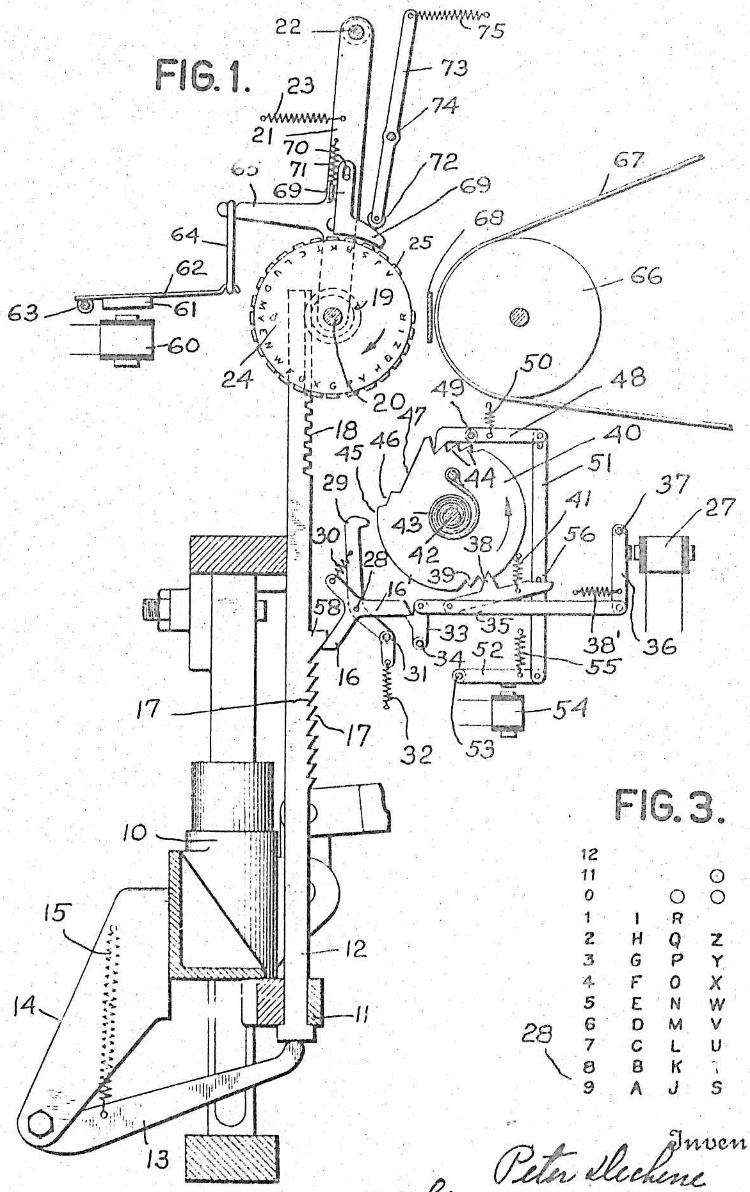

FIG. 3.

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Peter Dechene

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1902060

March 21, 1933. P. DECHENE 1,902,060

PRINTING MECHANISM

Filed Nov. 27, 1929 2 Sheets-Sheet 2

FIG. 2.

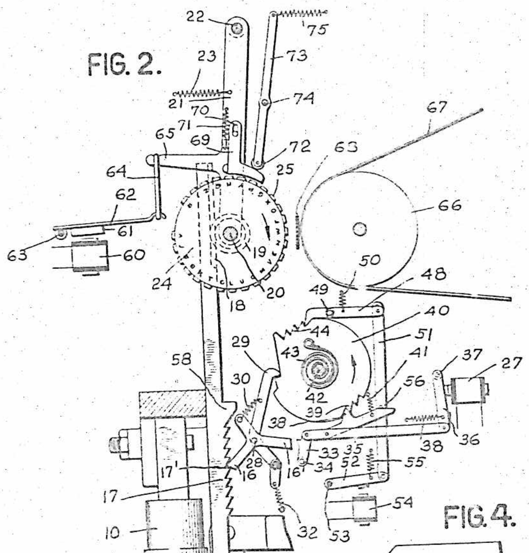
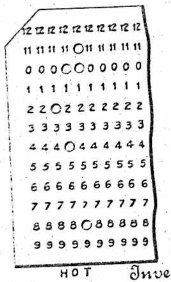


FIG. 4.



Inventor

Peter Dechene

By his Attorney

W M Wilson

UNITED STATES PATENT OFFICE

PETER DECHÊNE, OF BERLIN, GERMANY, ASSIGNOR TO THE TABULATING MACHINE COMPANY, OF ENDICOTT, NEW YORK, A CORPORATION OF NEW JERSEY

PRINTING MECHANISM

Application filed November 27, 1929, Serial No. 410,127, and in Germany December 13, 1928.

This invention relates to record card controlled machines and more particularly to the printing mechanism of such a machine in which alphabetical printing is desired.

It is the object of this invention therefore to provide means for selecting groups of printing elements and single printing elements within said groups by means of a single element.

Various other objects and advantages of my invention will be obvious from the following particular description of one form of mechanism embodying the invention or from an inspection of the accompanying drawings; and the invention also constitutes certain new and novel features of construction and combination of parts hereinafter set forth and claimed:

In the drawings:

Fig. 1 is a detailed elevation of type selecting and printing mechanism.

Fig. 2 is the same as Fig. 1 shown in the position of selecting a type element for printing.

Fig. 3 is a tabulation showing the letter groups and the index positions associated therewith.

Fig. 4 shows a portion of a record card punched to spell a word.

This printing mechanism may be substituted for or used in part with the printing mechanism shown and described in the application of C. D. Lake, Serial No. 639,153, filed May 13, 1923, now Patent No. 1,822,594. As this invention only concerns the printing and selection of the printing elements, the card feed, brush sensing mechanisms and controls have not been shown, they being the same as described in the Lake application mentioned above. The impulses transmitted from the sensing brushes by virtue of perforations in the cards passing the brushes effects the printing magnets to select the proper notch in the type bar carrier in the same manner and therefore for the sake of simplicity the type bar carrier and coacting selecting mechanisms only are shown.

In the preferred form of embodiment there may be provided a cross head 10 which is moved upwardly in timed relation to the feeding of record cards beneath sensing brushes not shown, situated in another part of the machine. As the method of card feed and the use of sensing brushes is generally known and fully described in the application to Lake previously mentioned and per se form no part of the present invention, it is deemed unnecessary to illustrate or explain them in detail. A comb 11 fixed to the cross head 10 has slidably mounted therein a plurality of type carrier members 12. Abutting the end of each of these members is a lever 13 pivoted to a bracket 14 fixed to the cross head. The lever 13 is biased upwardly by the spring 15 so that when the cross head rises the members are raised by spring pulled levers 13 until such time as the locking pawl 16 engages one of the teeth 17 integral with the member 12 at which time the member 12 is halted and the continued rising of the cross head causes the lever 13 to yield through the resiliency of the spring 15. Integral with the upper end of the member 12 is a rack 18 which meshes with a gear 19 pivoted at 20 to a lever 21 said lever being pivotally mounted at 22 to a lug fixed to the frame of the machine (not shown). The lever 21 is biased by a spring 23 in a clockwise direction about its pivot 22 to normally hold the gear 19 in mesh with the rack 18. Fixed to the gear 19 is a disk 24 having on its periphery raised alphabetical type indicia 25. As the member 12 rises the disk 24 rotates in a clockwise direction and the teeth 17 pass the locking pawl in synchronism with the passage of the index point positions of the card under the sensing brushes in another part of the machine. Thus when the sensing brush encounters a perforation it releases the pawl coacting with its corresponding type carrier member to engage the notch corresponding to that particular index point position. Thus, for example, if a card is perforated in the fifth index point position of the column corresponding to the mechanism shown in Figs. 1 and 2, the member 12 will rise in synchronism with the travel of the card and as the sensing brush encounters the perforation at the fifth index point position the fifth notch 17' will be opposite the locking pawl 16 and the magnet 27 will receive an electric impulse by virtue of the contact made by the sensing brush through said perforation.

Said impulse energizes magnet 27 and releases the locking pawl to engage the notch 17', and the mechanism is caused to bring the E type indicia into printing position when the member 17 reaches its final [illegible] position prior to the printing operation.

It will be noticed that the alphabet is divided into three groups A—I, J—R, S—Z (Fig. 3) these groups being assigned to the index point positions 1-9 inclusive, column 28 (Fig. 3) representing the index point positions relative to the alphabet. Thus the index point position 1 may designate either of the three letters A, J, S or the position 2 may designate either of the letters B, K, T, and so on as clearly shown in Fig. 3. The alphabetical type therefore is placed around the periphery of the disk 24 in a corresponding manner, thus A, J, S, B, K, T, C, L, U, etc., as shown in Fig. 1. The selection of one of the three letters for a given index point position is determined by the presence or absence of perforations at the 0 index point position or at both the 0 and 11 index point positions. If a perforation appears at the 4 index hole position only in a column the letter D will be printed; if at the 0 and 4 index point positions, the letter M will be printed and if in addition to the perforations in the two positions just mentioned there is a third perforation encountered at the 11 index point position, the letter V will be printed. Fig. 4 illustrates how a card may be perforated to spell the word [illegible] which is made up of three letters, one from each group. Although the second and third control holes are shown in the 0 or 11 index point position in the preferred embodiment described herein, it will be understood that these holes may follow the primary selecting perforated hole at any position following the same.

The locking of the member 17 in the proper position to cause a designated letter to be printed is accomplished by the pawl 16 which is pivotally mounted at 28 to a lever 29 and is biased in a clockwise direction by the spring 30. The lever 29 is pivotally mounted on a rod 31 which extends across the printing bank of the machine, said lever being normally held in the position shown in Fig. 1 by the action of the spring 32 fastened to said lever at one end and to the frame of the machine (not shown) at the other.

A latch 33 pivoted at 34 supports the arm 16' of the locking pawl 16 normally holding it out of contact with the notches on the member 17. A link 35 pivotally connects the latch 33 with an armature lever 36, said lever being pivotally mounted at 37 to the frame of the machine. A spring 36' biases the armature lever 36 in a clockwise direction thereby normally holding the armature away from its coacting electromagnet 27 and holding the latch 33 in latching position. Pivotally mounted to the link 35 is a pawl 38 coacting with ratchet teeth 39 on the periphery of a disk 40, said pawl being held in coacting relationship with said ratchet teeth by means of the spring 41. The disk 40 is rotatably mounted on a rod 42 which is supported by the frame of the machine (not shown). The disk 40 is biased in a clockwise direction by a coiled spring 43, one end of which is fixed to said disk and the other end to the rod 42. In addition to the ratchet teeth 39, the disk 40 has provided on its periphery a second series of ratchet teeth 44 and three position steps 45, 46 and 47 with which the lever 29 coacts to position the proper type element for printing. A pawl 48, pivoted at 49 and biased in a counterclockwise direction by spring 50 coacts with the ratchet teeth 44. The end of the pawl 48 is fastened by a pin and slot connection to a link 51 the other end of said link being pivotally fastened to an armature lever 52, pivoted at 53 and coacting with an electromagnet 54. Said armature lever 52 is resiliently held away from its coacting magnet 54 by a spring 55. Fixed to the link 51 is a pin 56 which coacts with the pawl 38 to withdraw it from the ratchet teeth 39 when the magnet 54 is energized.

In the description of the operation of this mechanism let it be assumed that the letter W is to be printed in which case the mechanism will take the position shown in Fig. 2. This will require a perforation at the 5 index point position on the card, one at the 0 index point position and one at the 11 index point position, all in the same column.

As the card passes under the sensing brush, the member 17 will rise in synchronism therewith so that when the perforation at the 5 index point position is under the brush, the stop pawl 16 will be opposite the 5th notch 17'. When the brush encounters the perforation an impulse is sent through the corresponding printing magnet 27 attracting its coacting armature lever 36 and withdrawing the latch 33 so that the locking pawl 16 turns clockwise about its pivot and engages the notch 17', then opposite said pawl. When the armature lever 36 is attracted by the magnet 27 the link 35 is moved to the right carrying the pawl 38 which is engaged in the ratchet teeth 39. This action rotates disk 40 in a counterclockwise direction so that the stop pawl 48 engages the next succeeding right hand ratchet tooth 44 and holds the disk in this new position. The member 17 now engaged by the locking pawl 16 continues to move upwardly and causes the lever 29 to be rotated clockwise about its pivot 31 until said lever abuts the stop position 45 on the periphery of the disk 40 at which time the upward motion of the member 17 is halted bringing the type E into printing position.

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The cross-head 10 continues upward while the lever 13 yields under the influence of spring 15. As the card continues under the brush the perforation at the 0 index point position causes another impulse to be sent through magnet 27, the energization of which causes the disk 40 to be advanced another notch in a counterclockwise direction, presenting the stop position 46 to the contacting point of the lever 29. Said lever being now unsupported, the member 17 will move upward again under the influence of the spring 15 and will turn the lever 29 counterclockwise until it abuts the stop position 46 at which point the type elements will be brought to rest with the letter N in printing position. Following this, the perforation at the 11 index point position causes a third impulse to be sent through the magnet 27 which advances the disk 40 another notch and presents the stop position 47 to the contact point of lever 29 so that the member 17 rises slightly further turning the lever 29 until it rests on said stop position 47, which moves the type element W into printing position.

It will be seen therefore that with the first perforation only existing in the column, the letter E will be stopped in printing position; with the first and second perforations only the letter N will be stopped in printing position, while the three perforations mentioned are required to present the letter W for printing.

When the cross-head 10 reaches the top of its stroke printing is effected in a manner to be described later. As the cross-head descends a contact (not shown) is closed which completes a circuit through magnet 54 thus energizing said magnet and attracting its armature lever 52, moving it clockwise about its pivot 53 and drawing the link 51 downwardly. The pin 56 engages the pawl 38, withdrawing it from the ratchet teeth 39 and the pawl 48 is turned clockwise about its pivot 49 thereby disengaging said pawl from the ratchet teeth 44. The disk 40, being thus unrestrained is restored to its normal position by the spring 43 and when the comb 11 restores the member 17 a projection 58 integral with said member strikes the pawl 16 turning it counterclockwise to restore it to its latched position, the latch 33 being always biased to the left by the spring 36'.

Printing is effected by energization of a magnet 60 occurring when the cross-head has reached the limit of its upward travel. When energized said magnet attracts its armature 61 fixed to a lever 62 pivoted at 63, at one end, the other end being formed into a hook shape which coacts with a stirrup 64 which rests in an indentation in an extended arm 65 integral with the lever 21. When the armature 61 is attracted the stirrup 64 is pulled downwardly causing the lever 21 to swing counterclockwise about its supporting pivot 22, thus moving the type disk 24 to the right and pressing the type element against a platen 66 over which is fed the paper 67 to receive the printing. The platen, the paper and the type [illegible] a well known type of platen and paper feeding mechanism may be used and as these play no part in the application it is believed that no further [illegible] is needed [illegible].

When the type disk 24 is moving to the right the gear 25 and [illegible] become disengaged, and in order to prevent said disk from rotating [illegible] provided a brake [illegible] fixed to the lever 21 by a [illegible]. The brake is normally held [illegible] position (Fig. 1) by means of [illegible]. Touching the upper side [illegible] roller 72 journalled in a [illegible] end of a lever 73 pivoted at 74 and biased [illegible] by the spring 75. As the brake is wedge-shaped, there is [illegible] against the roller 72 when the [illegible] to the right. As the roller 72 is [illegible] the brake 69 is forced downward against the type to lock the disk 24 from rotating. The sideward thrust of the roller 72 is compensated by the [illegible] spring 75.

Although a control single printing section has been described it will be understood that as many such sections as desired may be placed side by side to print words or sentences in one printing operation.

While there has been shown and described and pointed out the fundamental novel features of the invention as applied to a single modification it will be understood that various omissions and substitutions and changes in the form and details of the device illustrated and in its operation may be made by those skilled in the art without departing from the spirit of the invention. It is the intention therefore to be limited only as indicated by the scope of the following claims.

I claim:

1. A printing mechanism having a type carrier, a plurality of type divided into groups on said carrier and means for selecting the individual type in the groups by repeated operations of a single operating member during a single printing operation of said printing mechanism.

2. A printing mechanism having a plurality of type divided into groups, an operating member for selecting both the groups and the individual type within the groups and means cooperating with said member to effect group selection by the number of operations of said member and the individual type by the timing of the operations.

3. A printing mechanism having a plurality of type divided into groups, an operating member for selecting both the groups and the individual type within the groups and means

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cooperating with said member to effect group selection by the number of operations of said member and the individual type by the timing of one only of the operations.

4. A printing mechanism having a plurality of type divided into groups, mechanism for selecting both the groups and the individual type within the groups and a single electromagnet for operating said mechanism to effect both group selection and individual type selection.

5. A printing mechanism having a plurality of type divided into groups, mechanism for selecting both the groups and the individual type within the groups and a single electromagnet for operating said mechanism to select the groups by the number of energizations of said electromagnet and the individual type within the groups by a single energization of said electromagnet.

6. A printing mechanism having a plurality of type divided into groups, mechanism for selecting both the groups and the individual type within the groups and a single electromagnet for operating said mechanism to select the groups according to the number of energizations of said electromagnet and the individual type within the groups by the timing of the energization of said electromagnet.

7. A printing mechanism having a plurality of type divided into groups, selecting mechanism having a single operating member for normally selecting the individual type within a predetermined group said selecting mechanism also comprising mechanism cooperating with said single member to effect selection of other groups on repeated operations of said member during a single printing operation of said printing mechanism.

8. A printing mechanism having a plurality of type divided into groups, electromagnetically controlled selecting mechanism for normally selecting the individual type within a predetermined group, a single control electromagnet for said selecting mechanism and mechanism cooperating with the selecting mechanism to effect selection of type within other groups on repeated operations of said control electromagnet.

9. A printing mechanism adapted to be controlled by records bearing index points, comprising a plurality of type divided into groups, mechanism for selecting the groups and the individual type within the group including means responsive to the location of index points on a record for selecting the individual type and means cooperating with said first named means and responsive to any number of index points on a record including two in addition to the first mentioned index point for selecting the groups.

10. A printing mechanism adapted to be controlled by records bearing index points, comprising a plurality of type divided into groups, mechanism responsive to a single index point on a record for selecting the individual type within a predetermined group and means cooperating with said last named mechanism and responsive to a plurality of index points on a controlling record in addition to the first mentioned single index point to select the other groups of type according to the number of index points on the record.

11. A printing mechanism adapted to be controlled by records bearing index points, comprising a plurality of type divided into groups, mechanism responsive to data designating index points on record for selecting the individual type and mechanism cooperating with said last named mechanism and responsive to any number of index points on a record including two in addition to the first mentioned data designating index points, for selecting the groups.

12. A printing mechanism adapted to be controlled by records bearing index points, comprising a plurality of type divided into groups, a single selecting device for selecting both the groups and the individual type within the groups, mechanism responsive to data designating index points on records to control said single selecting device for selecting the individual type and mechanism responsive to any number of index points on a record including two in addition to the first mentioned data designating index points to control said single selecting device for selecting the groups.

13. A printing mechanism comprising a plurality of type divided into groups, a selecting member adapted by the time of its operation to select the individual type and having a plurality of operated positions to select the groups, means for operating said selecting member at different times to select the individual type and means for selecting the operated position of said selecting member to select the groups.

14. A printing mechanism comprising a plurality of type divided into groups, a selecting member adapted by the time of its operation to select the individual type and having a plurality of operated positions to select the groups, means for operating said selecting member at different times to select the individual type, means for selecting the operated position of said selecting member to select the groups and a common operating device for both of said means.

15. A printing mechanism comprising a plurality of type divided into groups, a selecting member adapted by the time of its operation to select the individual type and having a plurality of operated positions to select the groups, means for operating said selecting member at different times to select the individual type, means for selecting the position of said member when operated and a common operating device for both of said

means for selecting the type by [illegible] operation and for selecting the groups by repeated operations.

16. A printing mechanism having a type carrier with a plurality of [illegible] thereon and having the type of one group intermediate the type of another group, means for moving said [illegible] different positions, [illegible] determining the printing position of said carrier, means for [illegible] selecting the different [illegible] for controlling the position of said stop member when operated [illegible] the groups.

17. A printing mechanism having a type carrier with a plurality of groups of type thereon and having the type of one group intermediate the type of another group, means for moving said type carrier into different positions, a stop member for determining the printing positions of said carrier, means for operating said stop member for selecting the individual type, means for controlling the position of said stop member when operated for selecting the groups and a common operating device for both of said means.

18. A printing mechanism having a type carrier with a plurality of groups of type thereon and having the type of one group intermediate the type of another group, means for moving the type carrier into different positions, a stop member having a plurality of different operated positions for arresting the type carrier in its different printing positions, means for timing the operation of said stop member to select the individual type, means for controlling the position of said stop member when operated, and a common electromagnet for operating said first named means from a single impulse and said second named means from repeated impulses.

19. A printing mechanism having a type carrier with a plurality of groups of type thereon and having the type of one group intermediate the type of another group, a member for moving said carrier into different positions and a ratchet on said member, a stop pawl cooperating with said ratchet to stop the carrier in different positions, a cam cooperating with said pawl to control its positions when operated to permit selection of all groups of type and a common operating device to release said pawl for cooperation with the ratchet at different times to select individual type and to operate said cam to control the position of the pawl when operated.

In testimony whereof I hereto affix my signature.

PETER DECHÊNE.

May 16, 1933. J. R. PEIRCE 1,909,548

PERFORATED CARD CONTROLLED MACHINE

Filed Sept. 16, 1930 41 Sheets-Sheet 2

FIG. 2.

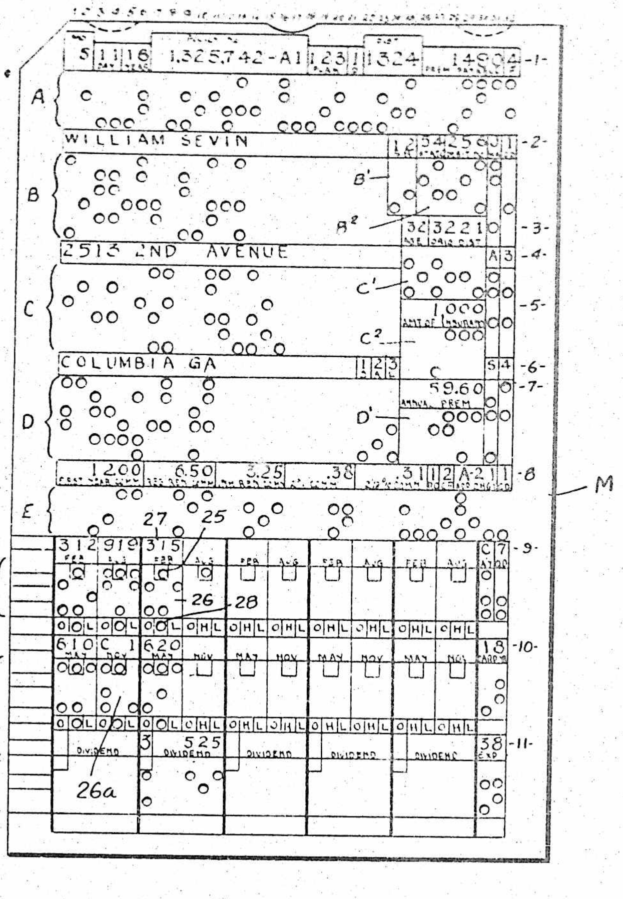
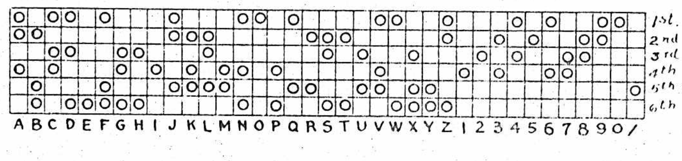


FIG. 3.



1st
2nd
3rd
4th
5th
6th
A B C D E F G H I J K L M N O P Q R S T U V W X Y Z 1 2 3 4 5 6 7 8 9 0 /

Inventor
John Royden Peirce
By his Attorney
[illegible]

Sept. 26, 1933.

A. W. MILLS

1,928,209

PERFORATED RECORD CARD

Filed Feb. 7, 1930

3 Sheets-Sheet 1

FIG.1.

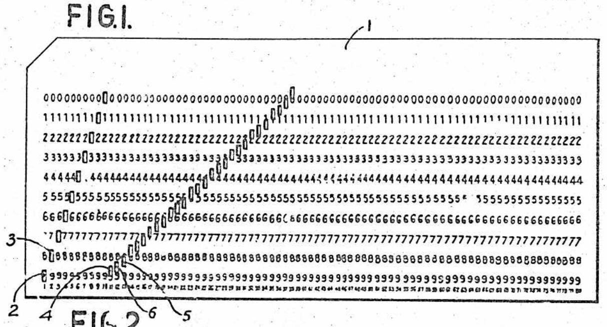


FIG.2.

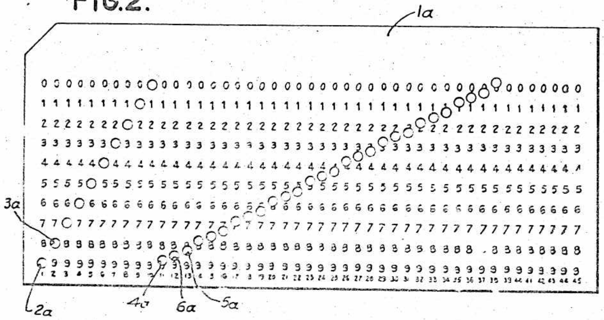
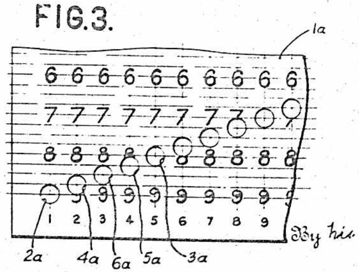


FIG.3.



Inventor

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By his Attorney

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Sept. 26, 1933.

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1,928,209

PERFORATED RECORD CARD

Filed Feb. 7, 1930

3 Sheets-Sheet 2

FIG.4.

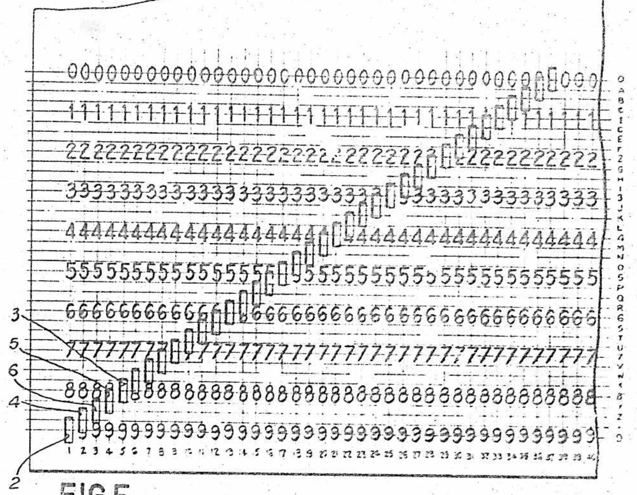
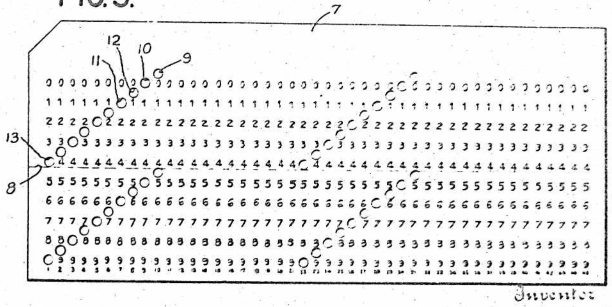


FIG.5.



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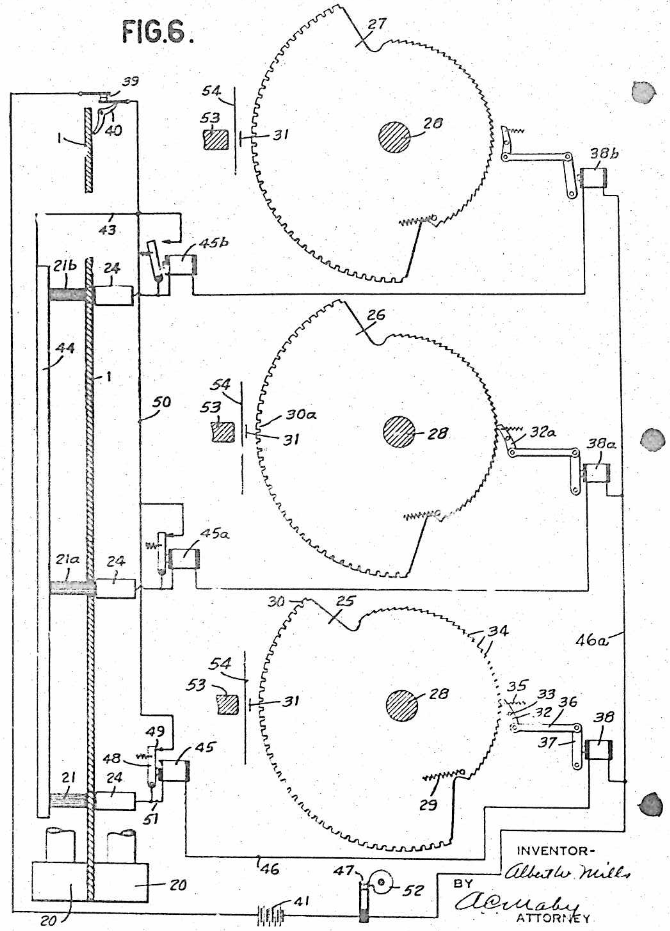
Sept. 26, 1933. A. W. MILLS 1,928,209

PERFORATED RECORD CARD

Filed Feb. 7, 1930 3 Sheets-Sheet 3

FIG.6.



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BY
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Patented Sept. 26, 1933 1,928,209

UNITED STATES PATENT OFFICE

1,928,209

PERFORATED RECORD CARD

Albert W. Mills, East Orange, N. J., assignor, by mesne assignments, to International Business Machines Corporation, New York, N. Y., a corporation of New York

Application February 7, 1930. Serial No. 426,581

3 Claims. (Cl. [illegible]—93)

This invention relates to record cards adapted for use in connection with perforated card controlled accounting machines such as the well known Hollerith tabulating machines. In such machines a record card is provided with a plurality of vertical rows of index point positions. A common form of card includes 45 such vertical rows with ten positions in each column for representing the numerals from zero to nine. Additional positions above the zero position may be employed to indicate additional data, such as 11 and 12, where it is desirable to record all of the months in a single column. In the usual system a single perforation is made in a vertical column. This perforation is made at a particular point to represent a particular numeral. For instance, if it is desired to record the numeral "9" in a particular column, a perforation will be made in the 9 position in that column, and so on. These cards are fed through tabulating machines and are sensed by electric current brushes under which the cards are fed. The positions on the card feed successively past the brushes and if a perforation appears in the 9 position of any column, the brush will reach through the perforation and make contact with an electric conductor on the other side of the card. It will close a circuit through electromagnets to cause the machine to effect accumulating operations to accumulate the 9 and also when desired to cause the machine to print the 9 on a record strip carried in the machine.

The card may also be analyzed by sensing pins in which case the card is stopped at a sensing position and the pins projected against the card. The pin detecting a perforation will pass through the card and control the accumulating and printing operations of the machine. Heretofore the number of characters entered in a single column on a card has been limited. It has been customary to effect punching in the columns at a very limited number of positions. In some instances in order to increase the capacity of a single column in order that alphabetical characters may be represented, two or more perforations were made in the column, the combination of perforations being used to control the operation of the machine.

The object of the present invention is to devise a system of perforating whereby a large number of characters may be represented by the punching of a single hole in a column on the card.

Referring to the drawings wherein I have shown what I now consider to be the preferred form of my invention:

Fig. 1 shows a card having 80 vertical columns, each column having ten numbered index point positions bearing the characters 0 to 9.

Fig. 2 shows a card of the same size having 45 columns of index point positions.

Fig. 3 is an enlarged section of the card shown in Fig. 2.

Fig. 4 is an enlarged detail section of the card shown in Fig. 1.

Fig. 5 shows a card similar to that of Fig. 2 in which the card may be divided across the middle and separate sets of data entered in the upper half and in the lower half.

Fig. 6 is a diagrammatic view showing the manner in which the card may be used to control the setting of type carriers to cause printing of values or characters represented by the perforations in the card.

In Fig. 1 the card 1 shows ten index point positions in each vertical column. Each of these positions represents one of the numerals from 0 to 9. A perforation in any one of these positions may represent the character printed in the position. Thus in the first column a perforation 2 is shown in the 9 position representing the value 9. In the second column a perforation 3 represents the value 8. In the remaining and succeeding columns, perforations represent the values 7 and so on down to zero. In the eleventh column a perforation 4 is shown slightly above the position of the perforation 2 of the first column. In the thirteenth column a perforation 5 is shown slightly below the position of the perforation 3 of the second column and in the twelfth column a perforation 6 is shown in a position midway between the positions of the perforations 4 and 5. Thus between each horizontal row of numerals additional perforation positions are employed. In Fig. 4 the perforation 2 is shown in the first column, the perforation 4 is in the second column, the perforation 6 is in the third column, the perforation 5 is in the fourth column and the perforation 3 is in the fifth column. This system is continued on up to the upper end of the columns so that instead of having only ten index point positions in each column, thirty-seven or more such positions may be used. Any one of these perforations may be made in the single column. If all of the perforations were made in a single column there would, of course, be a continuous slot from near the upper edge of the card, all the way to near the lower edge thereof, but it is to be understood that only one perforation will be made in a single column and such perforation will represent any one of thirty-seven or more different characters depending upon its position.

As shown in Fig. 1 the numerals may be represented by perforating the numbered index point positions as in the first ten columns. The positions between the numbered positions may be used to represent other characters such as the letters of the alphabet and additional characters. When so used any one of three letters of the alphabet may be recorded between adjacent upper and lower numeral index point positions. Thus a perforation in the upper position may represent 0, a perforation in the 1 horizontal line will represent the value 1, and perforations in the three intermediate positions may represent the letters A, B and C. In this manner all of the characters of the alphabet may be placed between the numerals and additional characters such as a period, comma, dash, etc., may be recorded. Any suitable machine may be employed for analyzing the card to ascertain the character represented by a perforation in a given position. It will, of course, be necessary that the perforation sensing elements be able to distinguish between the overlapping positions. In other words, the perforation sensing elements would sense the intersecting points of the horizontal lines designated 0, A, B, C, etc., and the vertical lines of each column. If an intersecting point is at the middle of a hole, the hole will record the data represented by the intersecting point. In Figs. 1 and 4 the vertical columns are very closely spaced and therefore an elongated perforation is used to represent data in any particular column. In Fig. 2 the columns are more widely spaced and the regulation round perforation may be employed. Here the card 1a has a perforation 2a in the 9 position of the first column.

The second column is perforated at 3a to represent the value 8. The eleventh column has a perforation 4a at a position slightly above the perforation 2a. The thirteenth column has a perforation 5a slightly below the position of the perforation 3a and the column 12 has a perforation 6a between the positions of the perforations 4a and 5a. Here again any one of the perforations may be effected in each column. In Fig. 3 the card 1a is shown as having a perforation 2a in the 9 index point position or column 1. The fifth column has a perforation 3a representing the value 8 and perforations 4a, 6a and 5a are recorded in columns 2, 3 and 4 respectively. In Fig. 5 the card 7 has a horizontal dotted line 8 dividing the card into upper and lower halves. The index point positions of each column in the upper half are numbered 0 to 4 inclusive, and the index point positions in the column on the lower half are numbered 5 to 9. In the tenth column in the upper half of the card, a perforation 9 above the upper horizontal row of numerals may represent zero, the perforation 10 may represent the value 1, the perforation 11 may represent the value 3, and an intermediate perforation 12 may represent the value 2 and so on down, the perforation at 13 representing the value 9. The perforations in the first 10 columns in the lower half of the card may in like manner represent the values from 0 to 9. The numbering of the index point positions in each column from 0 to 9 shows the relationship of the positions on a regulation Hollerith tabulating card. In the present system each column in the upper half of the card may, of course be numbered 0 to 9 instead of from 0 to 4 and the index point positions of each column on the lower half of the card may also be numbered 0 to 9 instead of 5 to 9 as shown here. If it is desired in the case of card 7 to record any one of the 12 months in a single column, this may readily be done by using the blank space at the top of the card for additional index point positions in each column. The manner in which the card is used to control the operation of a machine is shown in Fig. 6. Here the type of machine illustrated is that disclosed in the Hollerith Patent #1,295,167, dated February 25, 1919. The parts of the machine are shown diagrammatically and only so much is included as is necessary to understand the manner in which the card illustrated here is used to control the machine. In Fig. 6 the card 1 is shown in section and is viewed looking down upon the card which is being fed downwardly through the machine by the feed rollers 20. Three perforation sensing brushes 21, 21a and 21b are shown. In a tabulating machine, there would be one of these brushes for each column on the card and a separate contact block 24 is provided for each brush. Normally, the brushes engage their contact blocks 24 but as the card is fed downwardly through the machine, it separates all of the brushes from their contacts and thereafter during the passage of the particular card the various brushes will reach through the perforations in the card as these particular perforations move past the corresponding brushes. The time in the card feeding cycle at which a brush reaches through a perforation to make contact with the block 24 determines the control that the particular column on the card shall have upon the machine. In order to print the characters represented by the perforations a plurality of type carriers 25, 26, 27 are shown loosely mounted on a shaft 28. There is one of these type carriers for each of the perforation sensing brushes or in other words, for each column on the record card. A spring 29 is adapted to rotate the type carrier clockwise synchronously with the movement of the card past the sensing brushes. In other words, as each index point is passing the sensing brush, the corresponding type element or character is passing through the printing line. The mechanism for controlling this synchronous operation is more fully disclosed in said Hollerith patent. At the beginning of the card cycle all of the type carriers are in normal position with the first type element 30 just below the printing position which is approximately the middle of the inking ribbon 31. Assuming that the cards are being fed downwardly with their lower edge first the sensing brushes 21 will be separated from their contact blocks 24. Then all of the "9" positions across the bottom of the card will pass between the sensing brushes 21 and the contact blocks 24. At the moment that the leading edge of the perforation reaches this sensing brush the first of the type elements 30, representing the numeral 9, will be reaching and passing the printing position as the type carriers rotate upon the shaft 28. Wherever a perforation appears in a column on the card the corresponding type carriers will be stopped so that the type representing the numeral "9" will be held in printing position. The type carriers are adapted to be stopped by latching pawls 32 pivoted at 33 and normally held out of mesh with ratchet teeth 34 on the type carriers, by springs 35. The pawls 32 are connected by links 36 to the armatures 37 of the printing magnets 38. Each of these printing magnets is associated with one of the sensing brushes 21 and becomes energized when its brush reaches through a perforation in the card and closes the circuit by making contact with the block 24. Included in the control circuit is a set of contacts 39 adapted to be controlled by card lever 40. When no card is in the sensing position, contacts 39 are open so that no current will pass through the brushes 21 and contact blocks 24 which are then in engagement with each other. Just after the card reaches the sensing brushes and separates them from the contact blocks 24 and before the first perforation position reaches these brushes the card rocks the lever 40 and closes the contacts 39. Now when a perforation reaches a brush and the latter engages the block 24 on the other side a circuit will be closed from the source 41 through line 42, contacts 39, wire 43, to the common brush holder 44, then through any of the brushes that have made contact through the perforations with the block 24 then through a holding magnet 45, wire 46, printing magnet 38, line 46a, contacts 47 which are closed during the card reading cycle, and back to the other side of the source. As soon as the holding magnet has become energized it attracts its armature 48 closing contacts 49 so that the circuit will now be from the source 41 through line 42, contacts 39, wire 50, contacts 49, through the armature 48 which serves as a conductor to the wire 51, magnet 45, wire 46, magnet 38, wire 46a, contacts 47 to the other side of the line. The holding magnet 45 serves to keep the circuit closed after the perforation which effected the closure has passed the brush 21 and opened the circuit at that point. The relay magnet 45 holds the circuit closed until the end of the card cycle during which time the printing will have been effected. At the end of the cycle, a cam 52 permits the contacts 47 to open. This breaks the circuit through the magnets 45 and 38. Contacts 49 then open and the pawl 32 is restored to its normal position by spring 35 thus releasing the type carrier 25. The type carriers will then be restored in a counterclockwise direction to their normal positions in a manner more fully disclosed in the aforesaid patent.

In the illustration of Fig. 6, the parts are shown at a point about the middle of the card sensing cycle. One of the type carriers 25 has been stopped by reason of the brush 21 having made contact through a perforation. The brush 21a is shown reaching through the perforation in the card and engaging the block 24 so that its magnets 45a and 38a have just become energized and the pawl 32a has just been operated to stop the type carrier 26 in position with the type element 30a in the printing line. This type element represents the value corresponding to the perforation in the card which brought about energization of the magnets. The brush 21b has not yet encountered a perforation in its column and therefore its magnets 45b and 38b have not yet become energized and the type carrier 27 will continue to move synchronously with the passage of the card through the machine. This type carrier will be stopped later in the card cycle if a perforation is encountered by the brush 21b and will be stopped in a position corresponding to the value represented by the perforation. At the end of the card reading cycle the printing hammer or hammers 53 will operate to press the record sheet 54 and the inking ribbon 31 against the type elements in the printing line to effect printing on the sheet. It will be understood that as the leading edge of the perforation determines the time at which the magnets shall commence to operate, this will in turn determine the position at which the pawl 32 will engage the ratchet teeth 34. As long as the duration of contact in the card is sufficient to permit the operation of the magnets and the closure of the contacts 49, the type carriers will be stopped in their correct positions, and this has been found to be so even though the perforation reaches part way over the position allotted to the next character or in other words, the succeeding perforation position in the column.

Having described my invention, what I claim and desire to secure by Letters Patent is:

1. A record card on which differentially located points in a column represent different characters in a continuous system, such as the letters of the alphabet, and in which a perforation is provided at one of such points, said perforation overlapping an adjacent point representing a different character, a perforation at one of said points being adapted to operatively select a type element, a type element selected under control of a perforation at any one of said points being different from that selected under control of a perforation at any other point.

2. A perforated record card divided into a plurality of columns which are subdivided into a plurality of progressively located index points each representing a different character, and a perforation through the card at one of said points representing the corresponding character, said points being closer to each other than the dimension of the perforation in the columnar direction whereby a greater selection of characters may be represented by a single perforation in a column than where the distance between the points is greater than such dimension of the perforation, said card being adapted to be fed through a machine synchronously with the operation of a type carrier and being adapted to cause setting of the type carrier in a position corresponding to the position of a perforation in the column.

3. A perforated record card divided into a plurality of columns which are subdivided into a plurality of progressively located index points each representing a different character, and a perforation through the card at one of said points representing the corresponding character, said points being closer to each other than the dimension of the perforation in the columnar direction whereby a greater selection of characters may be represented by a single perforation in a column than where the distance between the points is greater than such dimension of the perforation, said card being adapted to be fed through a machine synchronously with the operation of a controlled member and being adapted to differentially control such member in accordance with the position of the perforation.

ALBERT W. MILLS.

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Sept. 12, 1933. J. W. BRYCE 1,926,892

PRINTING MECHANISM

Filed Aug. 28, 1930 8 Sheets-Sheet 4

FIG. 4.

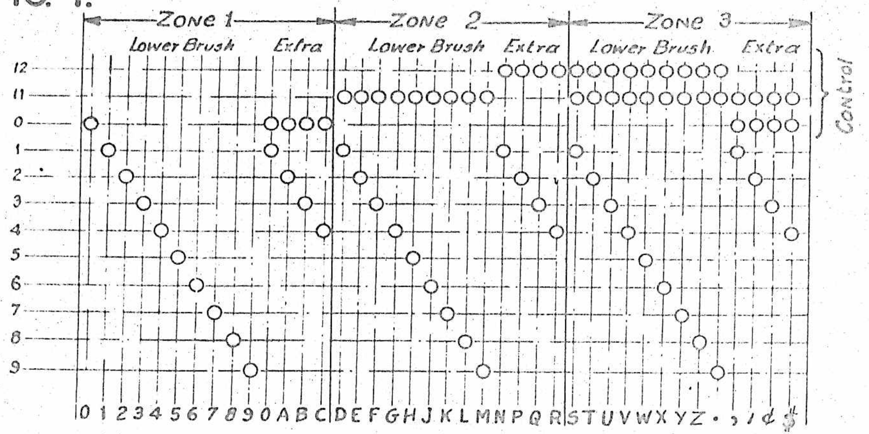

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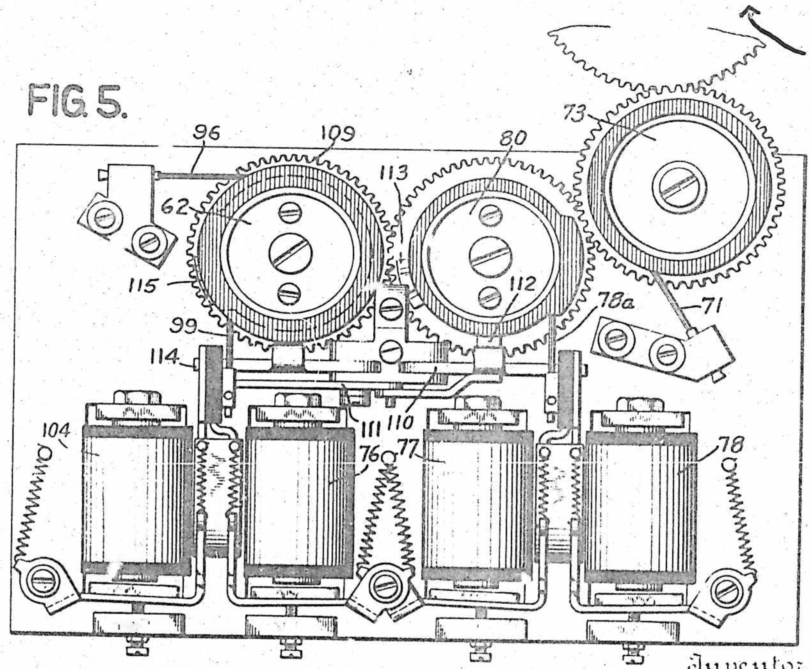
FIG. 5.



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James W. Bryce

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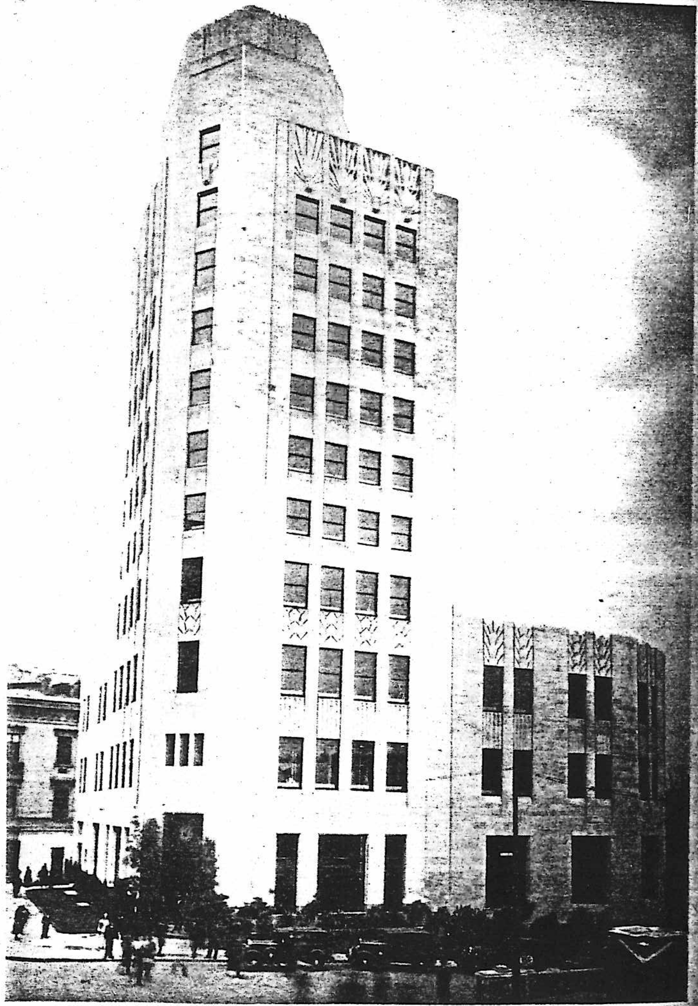
W. M. Wilson



Headquarters Building, Societatea Anonimă Română de Telefoane, Bucarest, Rumania

Electrical Communication
July 1934 v12

Improved Teleprinter Keyboard Technique

By F. R. THOMAS

Creed & Company, Limited, Croyden, England

THE introduction of Teleprinter Systems has had a profound influence on telegraph practice: for, since their introduction and substitution for the earlier Morse, Hughes, and other types of printer equipment, service has been sped up and costs reduced, with resultant stimulation to the earliest branch of electrical communication. Teleprinter Systems also have extended the scope and usefulness of telegraphy in commerce and industry so that today, for example, numerous firms have made provision for the rapid and exact transmission of orders, instructions, and information, between their offices and works.

Experience in these new fields focussed attention upon the desirability of providing Teleprinters with a keyboard conforming strictly to that of the commercial typewriter. This had hitherto been considered impracticable as it appeared to necessitate the use of a six-unit code which would have precluded inter-communication with existing systems.

Typewriter Characteristics

The commercial typewriter keyboard comprises four rows of keys. Each key controls a typebar carrying two type faces placed one above the other on the type-pad, these being known as the "upper case" and "lower case" type faces. The keys are labelled to correspond with the two type cases, and when the upper case is required it is preselected by depressing a shift key. This raises the type basket from the lower to the upper position.

The speed of operation is dependent only upon the ability of the typist.

Teleprinter Characteristics

The five-unit telegraph code used by Teleprinter Systems provides a maximum of thirty-two signal permutations. After allocating combinations to the various functions such as carriage return and line feed, twenty-eight are left for other purposes. In order to use these for letters, figures and punctuation signs it is self-evident that a "shift" mechanism must be incorporated in the printer. Two of the twenty-eight combinations are required for setting this mechanism in the required position, and there are thus left twenty-six combinations, each of which can be used for two characters.

Since the whole of one "case" is needed for the letters of the alphabet, the figures are included in the other "case" along with the punctuation signs, and it is necessary to transmit the appropriate shift signal to the printer when changing from one case to the other.

This departure from typewriter practice has necessitated typists receiving some preliminary instruction before operating Teleprinter keyboards.

There is a further difference in operation in that the speed of typing on Teleprinter Systems is limited by the transmission speed, which is seventy-two words per minute.

New Commercial Keyboard for Teleprinters

Creed & Company have now solved the problem of double case operation with the retention of a five-unit code by arranging for the automatic insertion of a shift signal whenever the sending of a figure or punctuation mark is required. In order to transmit this additional signal without slowing down the operation, a storage device has been provided which holds the permutations corresponding to the key last depressed until the appropriate shift signal has been automatically transmitted. This has enabled them to provide a keyboard conforming strictly to the commercial typewriter layout in which both figures and symbols are accommodated on the fourth row of keys, the symbols being selected by holding down a shift key. In the design of this new keyboard the physical dimensions in regard to the separation of the keys have been determined from a study of many well-known commercial typewriters (Figs. 1 and 2).

Incidentally, the provision of this storage feature frees the keyboard from the transmitting mechanism and so gives the operator relative freedom of operation from the limitation of the speed of the transmitting mechanism. The speed of line transmission is fixed at fifty bauds which corresponds to a continuous operating speed of approximately seventy-two words per minute.

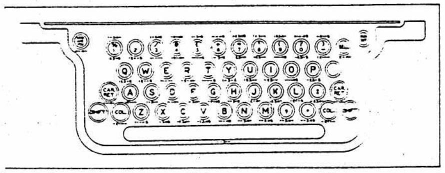


Figure 1

Commercial typists rarely operate continuously at speeds exceeding an average of 45 w. p. m., but when typing short words and frequently used syllables they often attain speeds over 100 w. p. m. When operating at a speed of 45 w. p. m., the typist is well below the Teleprinter transmission speed, and there becomes available time equivalent to 27 w. p. m. for use, with the storage device, for short typing spurts at high speed, and actually permits the operation of two keys in succession at the rate of 180 w. p. m., three keys at 168 w. p. m., four keys at 125 w. p. m., and so on, until finally the uniform transmission speed of 72 w. p. m. is reached.

Principle of Operation

The storage and shift insertion devices are shown schematically in Figs. 3A, 3B and 3C, in which 9 is a "letter" key, E; 5 represents permutation bars on which five-unit permutations are set up by the depression of any key; 2 is the first stage of storage; 4 is the second stage of storage; 10 represents the successive transmission of the five signal units; 7 is a "figure" key, 1; 6 is a control to all keys which, through 8, causes the second storage stage 4 to be connected to a permanently established "figure shift" 3 or "letter shift" 1, when a change of case is required.

Fig. 3A shows the normal condition existing after the depression of the letter E, key 9. The E permutation has been set up on the bars 5, transferred to the first storage 2, then to the second storage 4, and thereafter transmitted as five successive units. This condition persists until the next key is depressed. As the five units are transferred simulataneously from one storage stage to the next it will be seen that another key can be operated immediately the preceding permutation has been transferred from the bars 5 to the first storage 2. Before a third key can be depressed the first and second permutations must be passed onwards, and suitable locking means is provided at each stage to prevent the interference of successive permutations.

Fig. 3B shows the conditions established by the depression of a "figure" key 7 following a "letter" key. When the key is depressed not only is the appropriate permutation set up on the bars 5, and passed to the first storage 2, but the second storage is connected to the permanently established figure-shift permutation 3, which it picks up and transfers to the transmitter 10. The permutation in the first storage is held by a lock until the transmission of the figure-shift is effected, and it is then transferred to the second storage by the automatic reversion of the control 8 to the position shown in Fig. 3C.

A similar action takes place when a change from figures to letters is made, except that the control 8 connects the second storage to a permanently established letter-shift 1.

It will be noted that the controls 6 and 8 only operate where there is a change of case; that is, the appropriate shift signal is only transmitted when there is a change from letters to figures or vice versa.

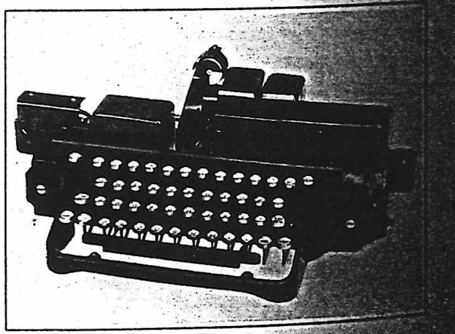


Figure 2

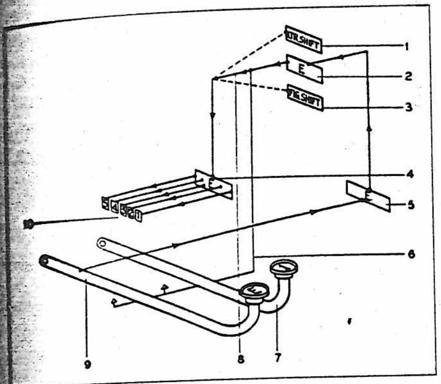


Figure 3A

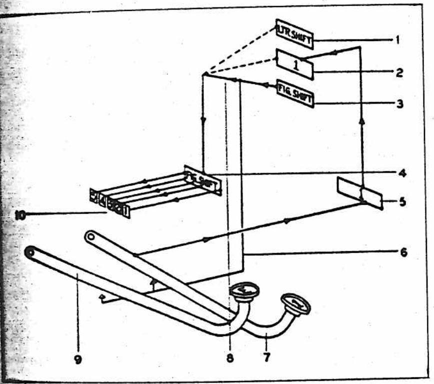


Figure 3B

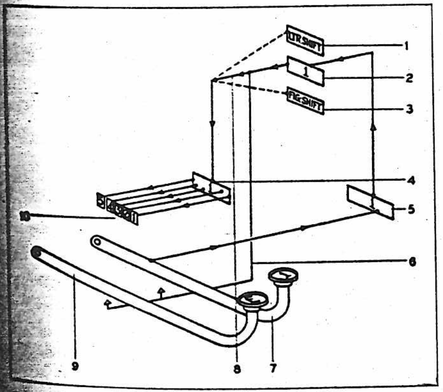


Figure 3C

From the foregoing it will be apparent that if a letter key and a figure key are operated alternately and continuously, the maximum speed permissible will be 36 w. p. m. as the appropriate shift signals have to be inserted automatically between each key depression, and therefore the number of permutations transmitted will be double the number of keys depressed.

In practice, however, case changes rarely occur more than twice consecutively as, for instance, in typing "the 3rd."; and, therefore, although almost the whole of the time margin available in the storage mechanism is absorbed by the two successive case changes, it is restored immediately the operator continues typing at normal speed in either of the two cases. Actually, one case change can be made at the rate of 140 w. p. m. and two consecutive case changes can be made at a speed of 72 w. p. m.

Storage and Shift Mechanism

The storage and shift mechanism (transfer unit), Fig. 4, forms one compact unit mounted above the key bars. It consists essentially of four frictionally driven cam shafts mounted side by side, and rotated in a clockwise direction. Each cam shaft carries a number of flat cams set in fixed angular relationship on a keyway.

The transmitting contact mechanism forms a complete unit mounted at the top left hand side of the transfer unit.

The mechanism required to provide automatic case insertion and storage, as well as the permutation changing mechanism, is indicated in Fig. 5.

Storage Operation

The depression of any key, 37 (Fig. 5), causes two separate combinations to be set up on five pairs of permutation bars, one pair only being shown—43 and 42.

The right hand ends of these bars have specially shaped slots, one bar of a pair being slotted in its upper edge, and the other in its lower edge.

A shift key, 31, when depressed, causes the lever 35 to rotate about its pivot 36. The right hand end of this lever is pivotally connected to a cradle 33 mounted on a pivot 30, and is normally held in its upper position by the spring 32. Pin 34 is rigidly connected to the cradle 33, and passes through slots in five connecting links 29

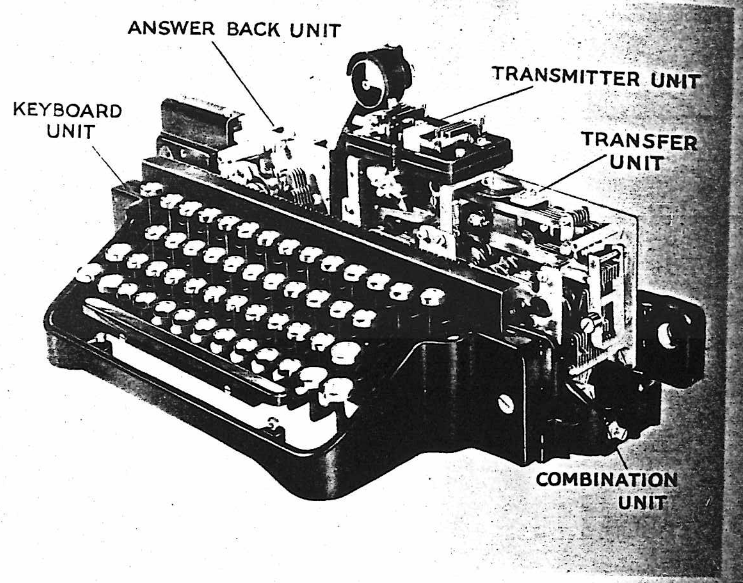


Figure 4

only one shown), there being one link for each pair of permutation bars.

At the lower left hand end of these connecting links are two projections. The upper projection can engage in the specially shaped slot of the rear permutation bar of a pair and the lower, in the slot in the front bar of a pair.

The depression of a character key, 37, positions the five pairs of permutation bars. In the case of the "letter" keys the combination established is the same on both sets of five bars, but in the case of the "figure" keys two different combinations are established. One combination is for the figure indicated in the lower case position on the key, and the other for the symbol indicated in the upper case position on the key.

The position of the shift key determines which of the two combinations will be transferred through the connecting links 29 to a mechanical relay mechanism. (The shift key is shown depressed in Fig. 5.)

The right hand ends of the connecting li 29 are pivotally connected to levers 27 wh engage with pivoted rockers 25.

The two transfer levers 17 and 18 are mount on pivots, and their bearings are slot-shaped order to permit lateral movement. The rock horns are so positioned that as one rises it ca the lower end of its transfer lever inwards, holds it in that position, and as the other rock horn falls it leaves its transfer lever free to mo outwards.

The upper ends of the transfer levers eng the slotted storage bars 19 which are free to mo endwise.

A cam 23 is driven through a friction clu (not shown) and rotates in a clockwise directi through a quarter of a revolution every ti key is depressed. During this quarter of a lution the diametrically opposed nodes of cam exert a spreading force at the centres of transfer levers. When this force is applied,

pper end of the transfer lever held by the raised cker horn is pushed outwards and carries the rage bar with it. As the other transfer lever unrestrained by its rocker horn it exercises no ntrol over the bar.

The combination set up on the permutation rs by the depressed key is thus transferred to e bars 19, and stored, the combination bars en being free to be reset by the depression of other key.

The left hand end of the storage bar 19 engages ith a rocker, 6, and with an associated transfer echanism similar to that already described.

It will be understood that each of the five nks, 29, is associated with a pair of transfer levers, and the cams are arranged to transfer all ve units of the selected combination simultaneously to the first storage bars.

After a predetermined interval the combination is passed on from the first storage bars to he second storage bars, 39, and so to the rockers, 40.

The upper ends of the transmitting levers 2 and 3 operate a common armature lever 4 and , and the cams, 38, are angularly displaced to operate each pair of transmitting levers in succession. The start and stop impluses for each combination are automatically inserted by independent transfer levers (not shown).

hift Operation

When a change of case is required, the case determining bar, 41, controls the mechnism for automatically inserting the figure and letter shift

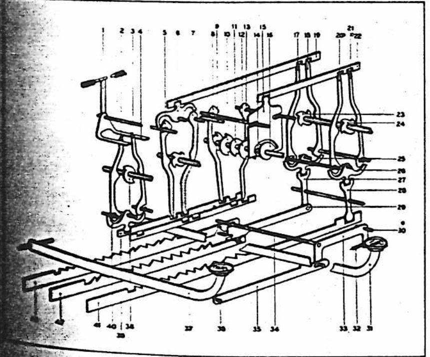


Figure 5

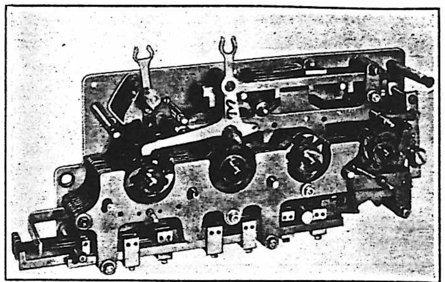


Figure 6

signals. It can occupy one of two positions. When letters (lower case) are being transmitted the bar, 41, is in the left hand position, and when figures are being transmitted it is in the right hand position.

This movement from one side to the other releases the automatic shift insertion mechanism, and causes the appropriate shift signal to be transmitted.

The bar, 41, controls the position of the shift release bar, 22. The left hand end of this bar engages with the shift detent, 15, which is free to move sideways. The shift release cam, 16, is frictionally driven in a clockwise direction, and when the detent is moved from one side to the other the cam is released, and rotates through half a revolution, after which it is again arrested by the detent.

Mounted on the same shaft are five other cams, four of which—9, 10, 12 and 14—have two projections, while the fifth or middle one, has only one projection. On the left hand side of these cams are five shift selection levers, 8 (one only shown), which are mounted with their upper ends restrained. On the right hand side of the cams only one shift selection lever, 13, corresponding with the middle (single projection) cam is provided. This lever is also restrained at its upper end.

The lower ends of all these levers engage with the second storage bars, 39, which are also engaged by the second transfer levers 5 and 7. As the shift cam shaft makes half a revolution from the position shown, all five of the left hand levers will operate their respective storage bars, and thereby set up the letter shift combination. The single lever on the right is not moved as there is no corresponding projection on the middle cam.

On depressing a key in the upper or "figure" case, the shift cam shaft makes the upper half revolution, and the first, second, fourth and fifth cam levers are operated as well as the single right hand lever. The figure shift combination is thus set up on the storage bars, and the transmitting cam shaft is then released and the signals transmitted as previously described.

Immediately after the transmission of the appropriate shift signal has been completed, the permutation stored on the bars, 19, is released for transfer to the bars, 39, and is then transmitted.

In addition to the mechanism shown there are lock and trip mechanisms associated with each shaft. These can be seen in the photograph, Fig. 6, which shows the transfer unit with its cover and front plate removed.

"Run-Out" Key

Another feature introduced in the new keyboard is the provision of a "run-out" key. By holding down this key the combination already set up in the transfer mechanism by the last character key depressed is transmitted continuously. This facility is not only useful for circuit testing purposes, but simplifies the work of the operator when tabulating or underlining. For example, when typing a continuous line under the heading of a letter, it is now only necessary to operate the "hyphen" key (-) once, and then hold down the "run-out" key.

"Answer-Back" Unit

In Fig. 1 a key is shown marked "Wh[illegible] you." The depression of this key transm[illegible] combination to the distant printer which [illegible] the release of an "answer-back" mech[illegible] Fig. 4. This consists of a frictionally-driven [illegible] inder carrying a number of wards in which [illegible] cut predetermined five-unit combinations. [illegible] cylinder is normally held at rest by a [illegible] which is disengaged on receipt of the signal [illegible] mitted by the "Who are you" key. As the [illegible] inder rotates the five-unit wards operate [illegible] cessively upon five selecting levers which [illegible] connected to the second storage bars, 39, Fig. [illegible] As each combination is set up on these ba[illegible] separate cam on the "answer-back" cylinder [illegible] trips the transmitting shaft, and the combination is transmitted back to the printer at the other end of the line. All keys on the keyboard [illegible] locked against operation during the rotation [illegible] the cylinder to prevent interference with the [illegible] going "answer-back" signals. The cylinder [illegible] brought to rest by the detent at the end of [illegible] revolution, and the keybar lock is removed.

This feature was primarily designed [illegible] in person-to-person communication to enable [illegible] calling subscriber to verify that the correct [illegible] nection had been established, but it is [illegible] use in point-to-point services when there [illegible] attendant at the receiving instrument, [illegible] ables the sending operator to verify that [illegible] distant machine is working.

The Measurement of Small Values of Inductance and Effective Resistance

By J. K. WEBB, M.Sc., A.M.I.E.E., and C. BROOKES-SMITH

Standard Telephones and Cables, Limited

In connection with the development af the continuous loaded telephone cable, it has been found desirable to measure accurately the inductance and effective resistance of very short samples, as well as the magnetic properties of the loading material. Details are given of a bridge suitable for this purpose.

Introduction

THE behaviour of cables used for communication purposes depends on the four parameters, dielectric capacity, leakance, inductance. and effective resistance. In experimental work. considerable saving may be effected if these can be determined accurately on very short samples of the order of about two metres upwards. From these measurements a reliable forecast of the constants of the final cable may be deduced.

In the case of dielectric capacity and leakance, the well-known capacity and conductance bridge[1] fulfils all requirements. but for the measurement of the remaining two parameters, no analogous bridge has been available, and consequently it has been necessary to develop one.

This bridge, known as the a-c.-d-c. bridge, in addition to inductance, measures the resistance to alternating and direct current of the sample under test and hence, by subtraction, the increment of resistance due to inductive effects such as the skin effect in the copper conductor, and the eddy current and hysteresis loss in the loading material.

Measurements with a-c. and d-c. may be made without disturbing the sample in such quick succession that errors due to change of temperature are obviated.

The bridge can also be used to measure the magnetic properties of very small samples of the loading material, i. e., permeability, hysteresis, and eddy current loss at known field strengths and, in the case of cables for carrier frequencies, the effect of the screening, lead sheath, and armour on the resistance increment. Tests performed before and after removal of the metallic components surrounding the conductor enable valuable empirical data to be obtained. It has been found possible to obtain complete magnetic and loss data on a length of only two metres of 0.1 millimeter loading wire.

Bridge Circuit Employed

Since there are a variety of well-known methods available for the accurate measurement of small inductances, the main problem has been the determination of effective resistance in increments as low as 0.0001 ohms at very low field strengths in the loading material and, hence, correspondingly low currents in the sample.

The range of measurement found most desirable was inductance from 1 to 300 microhenries, and resistance from 0.0001 to 10 ohms over the frequency range of 100 to 70,000 cycles p.s. These limitations greatly restrict the choice of circuit in order that accuracy may be combined with sufficient sensitivity while errors, due to stray capacities, inductances, and contact resistances, may be kept negligible.

A simple substitution method has been found most effective in meeting these requirments, the circuit being given in Fig. 1. This is essentially an equal ratio bridge in which an initial zero balance is obtained with the sample short circuited. After the short circuit across the sample is removed, balance is restored by decreasing the variable inductance and resistance in the same arm as the sample, the other three arms of the bridge remaining undisturbed. The amount of such decrease gives a measure of the effective

---

[1] G. A. Campbell: *Bell System Tech. Jnl.*, Vol. 1, No. 1, July, 1922. W. J. Shackleton and J. G. Fergusson: *Bell System Tech. Jnl.*, Vol. VII, No. 1, Jan., 1928.

Nov. 27, 1934.

F. M. CARROLL

1,981,990

PRINTING MECHANISM

Filed Dec. 20, 1932

2 Sheets-Sheet 2

FIG. 2.

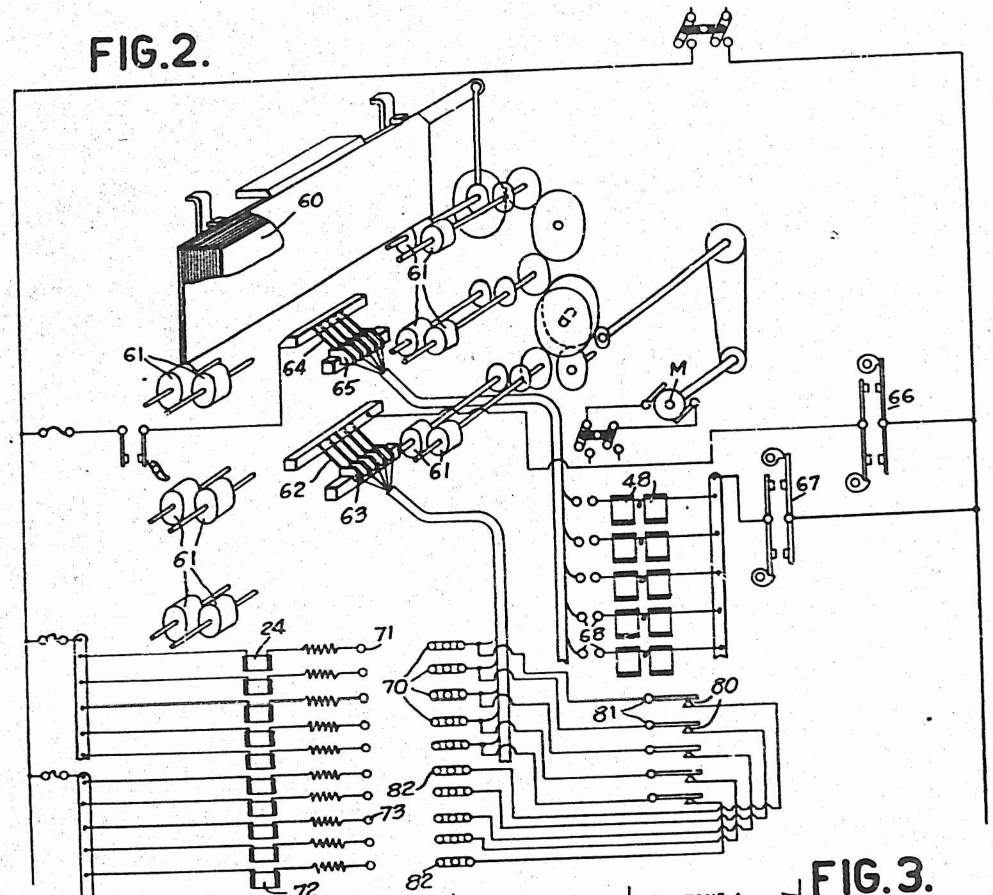
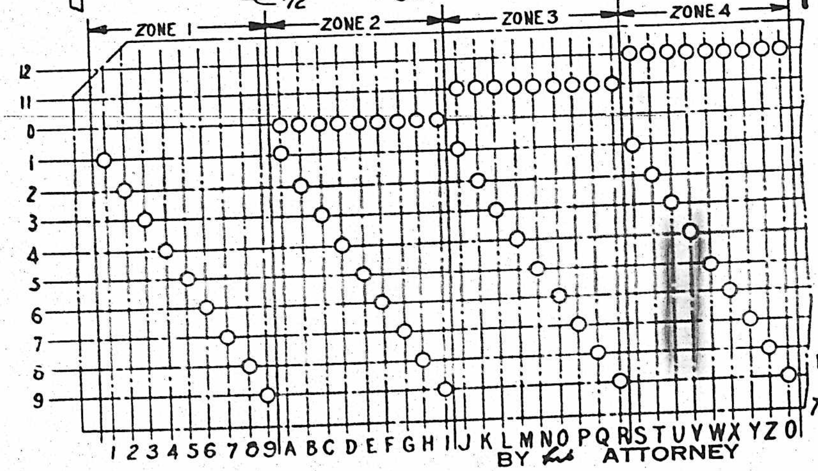


FIG. 3.



ZONE 1
ZONE 2
ZONE 3
ZONE 4
12
11
0
1
2
3
4
5
6
7
8
9
1 2 3 4 5 6 7 8 9 A B C D E F G H I J K L M N O P Q R S T U V W X Y Z 0

INVENTOR

Fred M. Carroll

BY his ATTORNEY

W M Wilson

Nov. 27, 1934. J. W. BRYCE 1,981,987

WORD PRINTING MECHANISM

Filed May 25, 1933 4 Sheets-Sheet 4

FIG. 7.

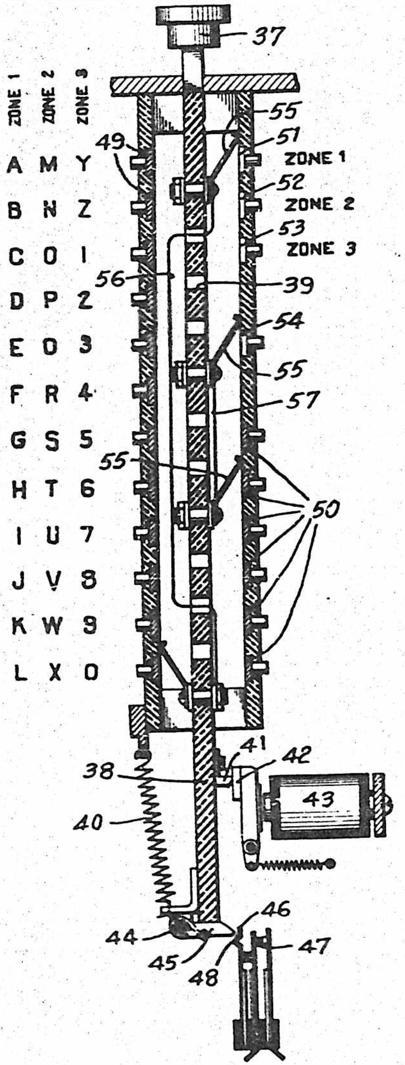


FIG. 6.

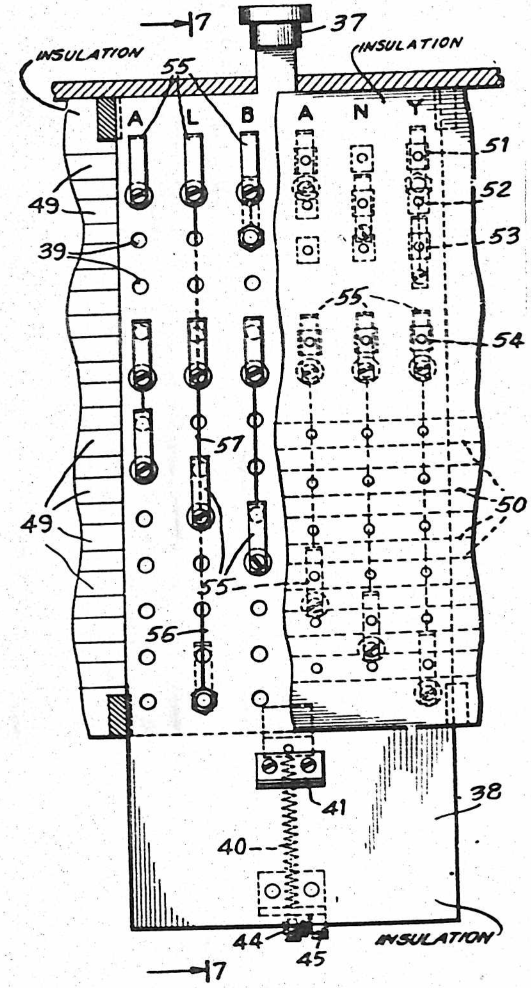
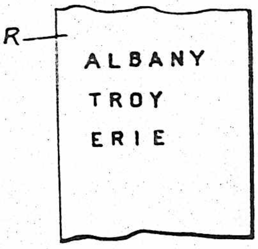


FIG. 8.



INVENTOR

James W. Bryce

BY

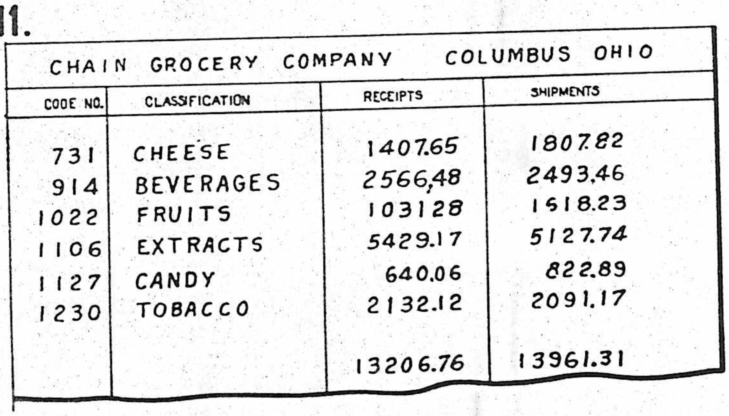
ATTORNEY

March 19, 1935. C. D. LAKE 1,994,524

PRINTING DEVICE

Filed Sept. 29, 1932 6 Sheets-Sheet 6

FIG.11.



CHAIN GROCERY COMPANY COLUMBUS OHIO

CODE NO.	CLASSIFICATION	RECEIPTS	SHIPMENTS
731	CHEESE	1407.65	1807.82
914	BEVERAGES	2566,48	2493.46
1022	FRUITS	103128	1518.23
1106	EXTRACTS	5429.17	5127.74
1127	CANDY	640.06	822.89
1230	TOBACCO	2132.12	2091.17
		13206.76	13961.31

FIG.12.

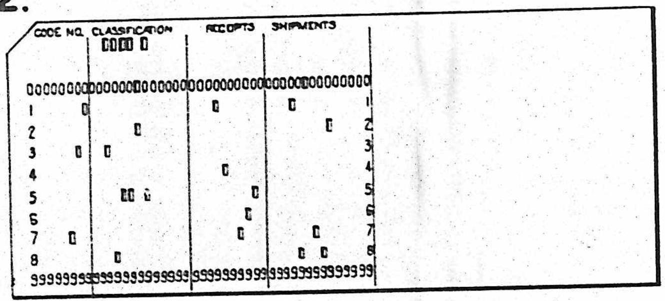
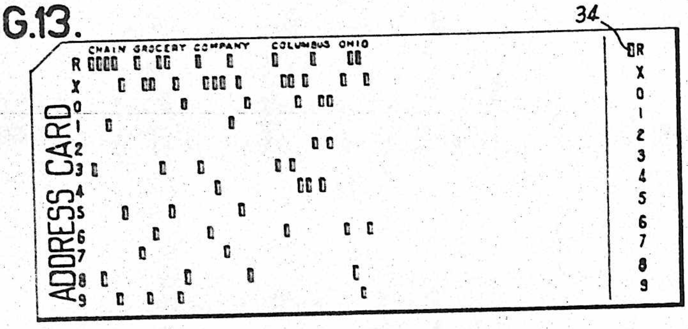


FIG.13.



INVENTOR

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W M Wilson

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Aug. 6, 1935. G. TAUSCHEK 2,010,652

PRINTING MECHANISM

Filed Sept. 6, 1933 2 Sheets-Sheet 2

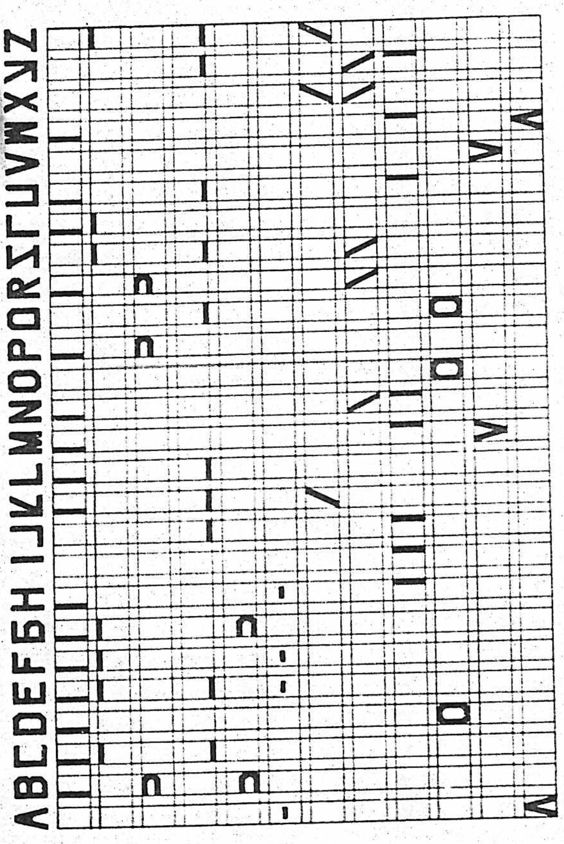

FIG.5.

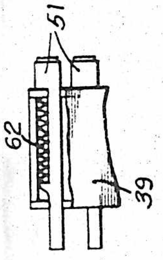

FIG.6.

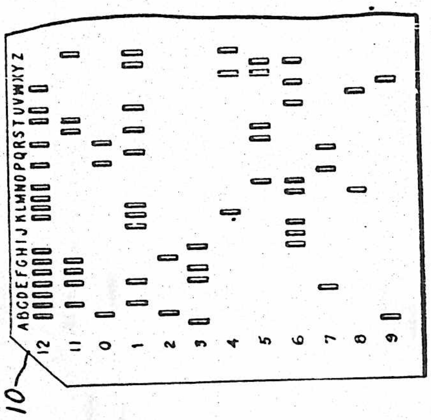

FIG.3.

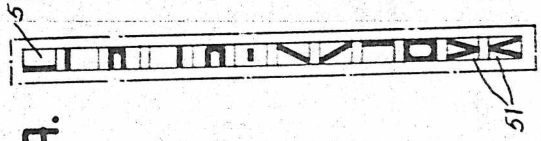

FIG.4.

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Oct. 8, 1935. A. W. MILLS 2,016,681

PERFORATED RECORD CARD

Filed April 23, 1932 2 Sheets-Sheet 1

FIG.1.

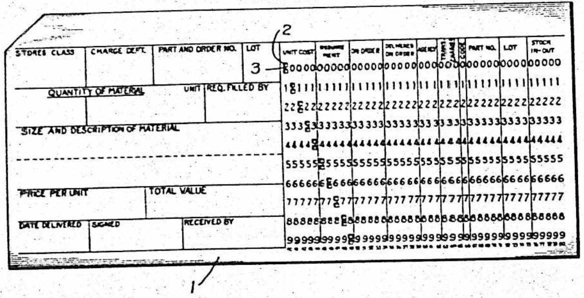


FIG.3.

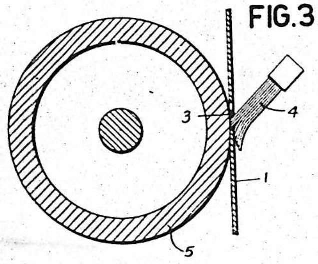


FIG.2.

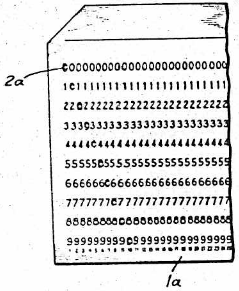
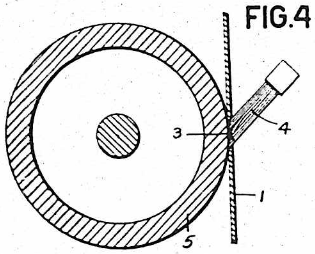


FIG.4.



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Oct. 8, 1935. A. W. MILLS 2,016,681

PERFORATED RECORD CARD

Filed April 23, 1932 2 Sheets-Sheet 2

FIG.5.

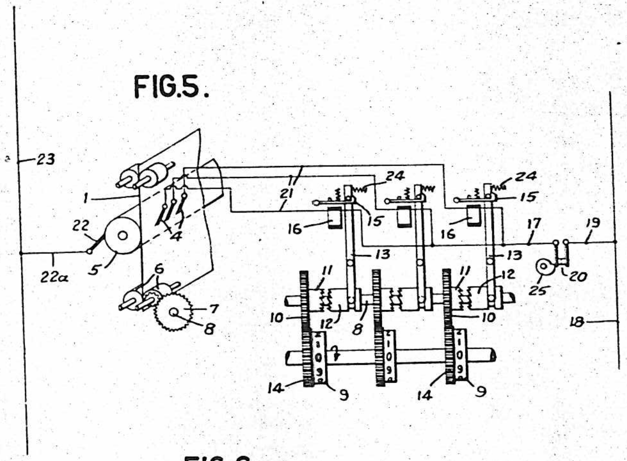


FIG.6.

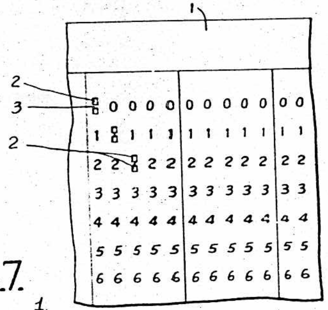
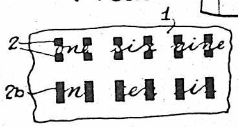


FIG.7.



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2016681

Patented Oct. 8, 1935 **2,016,681**

UNITED STATES PATENT OFFICE

2,016,681

PERFORATED RECORD CARD

Albert Washington Mills, East Orange, N. J., assignor, by mesne assignments, to International Business Machines Corporation, New York, N. Y., a corporation of New York

Application April 23, 1932, Serial No. 607,114

1 Claim. (Cl. 235—1)

This invention relates to perforated record cards for controlling tabulating, sorting and other accounting machines. Record cards used in the Hollerith system have for a long time contained adjacent columns of index point positions in which a round perforation is made in one or more of the positions in each column to indicate a value. According to U. S. Patent #1,772,492 the perforations are long in the vertical direction and narrow in the horizontal direction, thus making it possible to increase the number of columns of perforations and at the same time to produce a record card which after all the data has been entered is stronger than in the case of the earlier card in which the perforations were round.

It is often desirable to enter data upon the record cards by writing or typing in words and figures before the data is entered in the form of perforations. Operators then take the cards and enter the data by perforating in the appropriate columns of index point positions. The perforations often obliterate some of the hand writing or typing and render it difficult to read correctly. I have found that by using two smaller perforations in the place of one of the elongated perforations of Patent #1,772,492 less of the written information on the card is obliterated and it is easier to read such written data after the card has been perforated. On the other hand, this double perforation does not interfere with the usual operation of the tabulating or sorting or other accounting machines in which the card is employed.

Referring to the drawings in which I have shown what I now consider to be the preferred form of my invention:

Figure 1 represents a record card perforated in accordance with my invention;

Figure 2 shows a card in which single small perforations are employed;

Figure 3 is an enlarged sectional detail view showing the manner in which the perforations are analyzed as the record card passes through the machine;

Figure 4 is a similar view with the card slightly farther advanced through the machine than Figure 3;

Figure 5 is a wiring diagram of a tabulating machine controlled by the card;

Figure 6 is a portion of a card on an enlarged scale showing the double perforations.

Fig. 7 is an enlarged detail showing the manner in which the double punching sometimes makes it possible to read writing on a card where a single large perforation would make it difficult or even impossible to read the words.

In perforated record controlled machines such as tabulating or card sorting machines, it is customary to feed the cards one at a time to a set of electric brushes, the brushes pressing against the card as the latter moves through the machine. When a perforation reaches a brush, the brush passes through the perforation and makes contact with a terminal on the opposite side of the card and in this way closes a controlling circuit through the perforation, to effect the proper operation of the machine. The number of cards fed through the machine over a given period has become standardized within certain limits of speed. With cards feeding at the desired speed, the duration of contact through the perforation must be sufficient to bring about complete energization and operation of the electromagnet which it controls. The duration of contact is thus controlled by the length of the perforation. The length of the perforation has therefore become standardized under normal conditions. To decrease the length of the perforation a substantial degree would necessitate lowering the speed of the machine in proportion or else it would hamper the accuracy of the machine.

I have found, however, that by using two small perforations instead of one large one to represent a given value, the outer extremities of the two perforations being equal to the distance of the outer extremities of the single larger perforation, the same duration of contact may be maintained. The multiwire brush which senses the perforations will maintain contact through the two perforations without breaking the circuit while passing from one perforation to the other. The double perforation thus has the advantage of a single long perforation so far as duration of contact is concerned and has the advantage of not cutting out so much of the record card. In this way, written data is less apt to be obliterated by the punching of a card than where the single long perforation is employed.

In Figure 1, the card **1** is shown as divided into two portions. The left half of the card is arranged for written entries and the right half for perforated entries. If the card were used strictly in accordance with this arrangement then the single large perforations in the right half would not interfere with written entries, but it is often desirable to make written entries on the right half of the card also and it is sometimes desirable to make perforated entries on

---

the left side of the card where the written entries are made and again it is desirable to make written as well as perforated entries across the entire width of the card. In such instances, the double small perforations make this possible where a single larger perforation would often make it impossible to read the writing correctly. The double perforations are shown at **2** on the right side of the card. According to this method of punching, a strip of paper stock **3** remains between the upper and lower perforations so that where the perforation cuts through a written character, part of the writing continues to be visible on the intervening strip thus making it easier to read the writing. In analyzing record cards the cards are fed one at a time between brushes **4** and a contact member which is here shown as a roller **5**. The brush and roller are included in an electric circuit which contains an operating magnet so that when the brush engages the roller it closes the circuit through the magnet and thus controls the operation of the machine.

As the card passes between the roller and the brush the fine strands of the brush reach through the perforations and engage the roller thus closing the circuit. The time at which the circuit is closed with respect to the cycle of operation of the machine determines the nature or value of the control effected upon the machine. This in turn, of course, depends upon the position of the perforation in the particular column on the card. The length of time that the brush is in contact with the roller through the perforation is important because some definite length of time is required for the electromagnet to operate. If the card is fed too rapidly the circuit through the perforation is closed for so short a time that the magnet does not become fully energized and does not have time to operate. If the perforation is too small this reduces the duration of contact and the magnet will not operate. In the case of the double perforation as disclosed here the strands of the analyzing brush enter one of the perforations and then ride out of this perforation and drop into the next one. While this is happening additional strands are falling into the first perforation, thus maintaining the circuit until the last of the strands are lifted out of the second perforation. In this way, the circuit is maintained closed for the same duration of time where the intervening strip of paper is left between the two perforations as where it is cut out to make one elongated perforation.

Figure 3 shows the upper strands of the sensing brush **4** in contact with the roller **5** through the lower part or perforation of the double perforation. In Fig. 4, the card has been fed a little farther and these strands have been lifted out of the lower perforation and have dropped into the upper perforation, again making contact with the roller. In the meantime other strands of the brush have passed through the lower perforation as shown in Fig. 4, thus making contact with the roller.

As the strands are now lifted out of the upper portion of the hole, additional strands will fall into this portion maintaining contact with the roller until the last strands are lifted out. Besides making it possible to perforate a record card upon which written entries have been made the double perforation while making it possible to maintain the same duration of electrical contact as in the case of a single elongated perforation also produces a card which when fully perforated is much stronger than a similar card punched with the elongated hole and still stronger than the card punched with the larger round holes.

In Figure 2 the card **1*a*** is shown with single small perforations **2*a***. Such a perforation may be employed but where the brush is of the same dimensions as in Figs. 3 and 4 the duration of contact will be shorter and it will be necessary to feed the card more slowly through the machine than where the double perforation of Figs. 1, 3 and 4 is used. On the other hand the duration of contact through the double perforation is the same as in the case of the single elongated perforation and it is possible to feed the card through the machine at the same speed as where the single elongated perforation is employed.

By increasing the distance between the upper and lower perforations and using a brush which is still capable of cooperating with the second perforation before ceasing to cooperate with the first, the duration of energization of the control magnet may be materially lengthened.

Fig. 7 discloses a fragment of a record card having the double small perforations **2** and the single long perforation **2*b***. Words are written between or through the perforations in such manner that in the case of the double perforation, the words may be read whereas in the case of the single larger perforation so much of each word is punched out that the words cannot be read. This view shows extreme cases. In actual practice, the results will, of course, be somewhat between these two extremes but it will be seen that the double perforation has a marked advantage over the single larger perforation.

In Figure 5 the card **1** is shown as being fed by feed rollers **6** so that it passes between the contact roller **5** and the sensing brushes **4**. The feed rollers are driven through gearing **7** on shaft **8** which is also adapted to drive an accumulator **9**. Loose on the shaft **8** is a gear **10** provided with a clutch member **11** adapted to be engaged by a clutch member **12** which is slidably mounted on the shaft **8** but constrained to rotate therewith.

A spring pressed clutch operating lever **13** cooperates with the clutch member **12** and is adapted to move the latter into engagement with member **11** so as to cause the gear **10** to rotate. This gear meshes with gear **14** fixed to the accumulator member **9**. A latch **15** is adapted to normally hold the clutch member **12** disengaged from member **11**. This latch also serves as the armature of an electromagnet **16**. The magnet is connected by a wire **17**, through contacts **20** and wire **19** to one side **18** of the electric supply line. The other side of the magnet is connected by wire **21** to sensing brush **4** which is adapted to make contact with the roller **5**. The roller **5** on the other hand, is connected to a common brush **22** which is connected by a wire **22*a*** to the other side **23** of the line. As the card is fed between the sensing brush and the roller **5** the brush reaches through the perforations thus closing the circuit from the left side of the line through the magnet **16** to the other side of the line. The energization of the magnet causes the latch **15** to release the lever **13** and the spring **24** causes the clutch member **12** to mesh with member **11** to turn the gears **10** and **14** and thus actuate the accumulating wheel **9**. This type of accumulating mechanism is shown in many U. S. patents

2016681

including No. 1,534,532 and No. 1,658,023 and is well known in this art so that it need not be shown in all its details here.

The contacts **20** are controlled by a cam **25** and are closed during the time that the card **1** is passing between the sensing brush and roller **5** and are open when no card is between the brush and roller so that the circuit through the magnet **16** will not be closed between cards.

According to the present invention, as the card is fed past the brushes **4** the strands of the sensing brush will reach through the lower one of the two perforations **2** at any one of the index point positions on the card thus causing energization of the magnet **16** to close the clutch **11—12**. As the card continues to feed downwardly, the strands of the brush will ride into the upper one of the holes **2** and additional strands will ride into the lower one of the holes as in Figure 4 thus continuing the energization of the magnet **16** until the last of the strands ride out of the upper hole **2**. During the passage of the double perforation with respect to the sensing brush **4** the brush will maintain closure of the circuit through the magnet **16** first through one of the perforations then through both of the perforations simultaneously and then through the other of the perforations without any break in the continuity.

What is claimed is,

A record card for controlling accounting machines provided with columns each having a plurality of value positions, said card being provided with a plurality of separate perforations at one of said positions in a column for controlling a machine in accordance with the value corresponding to said position.

ALBERT W. MILLS.

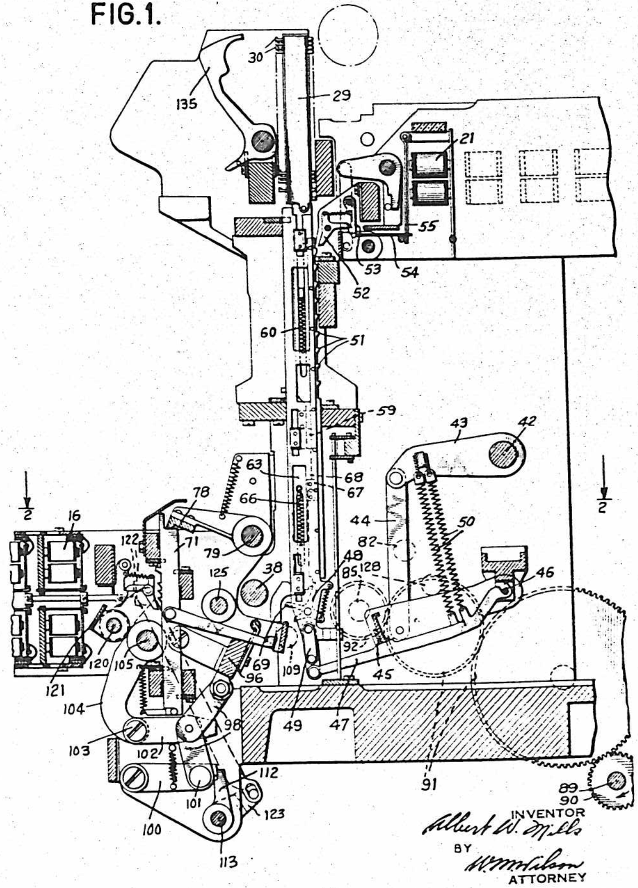
2016682

Oct. 8, 1935. A. W. MILLS 2,016,682

PRINTING MECHANISM

Filed Sept. 24, 1932 7 Sheets-Sheet 1

FIG. 1.



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Oct. 8, 1935.

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PRINTING MECHANISM

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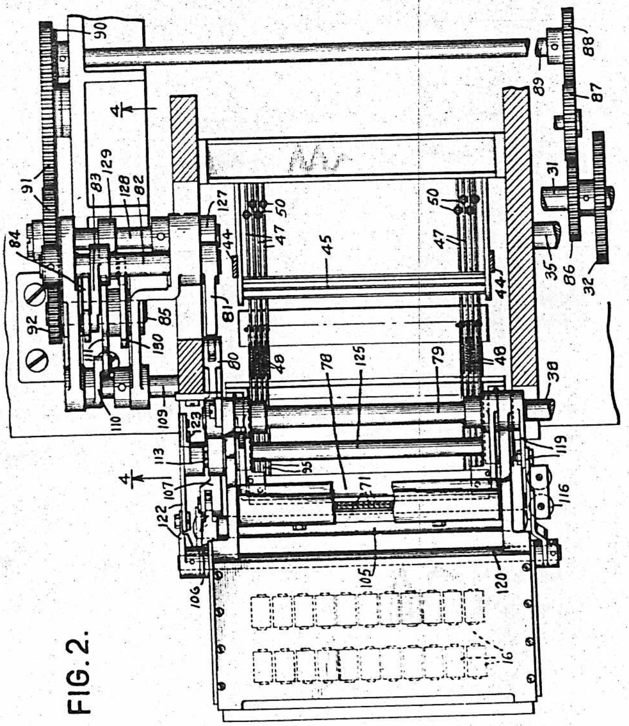

FIG. 2.

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FIG. 4.

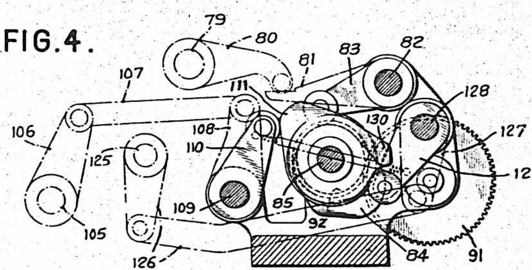

FIG. 3.

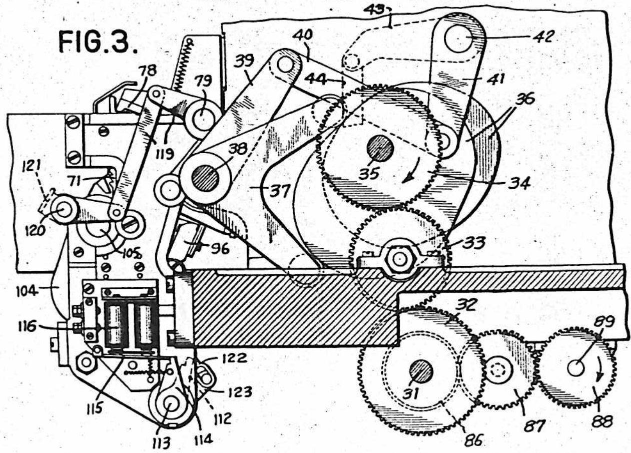

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FIG. 15.

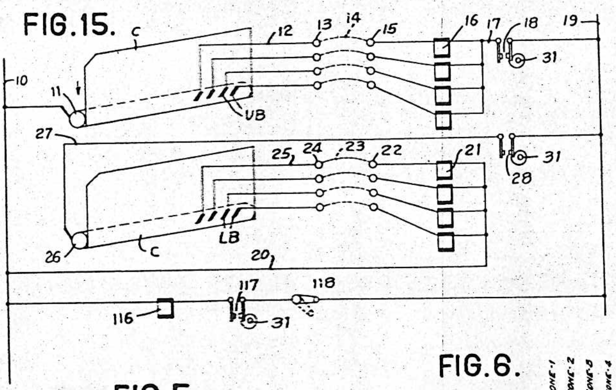

FIG. 5.

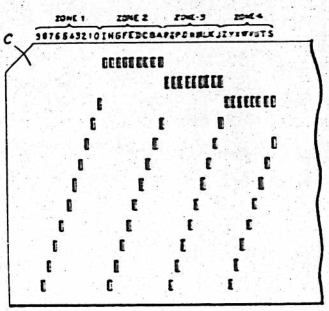

FIG. 6.

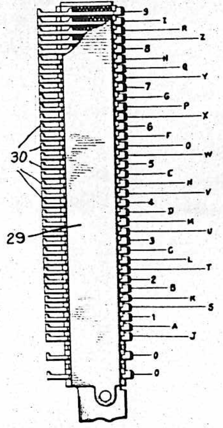

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FIG. 7.

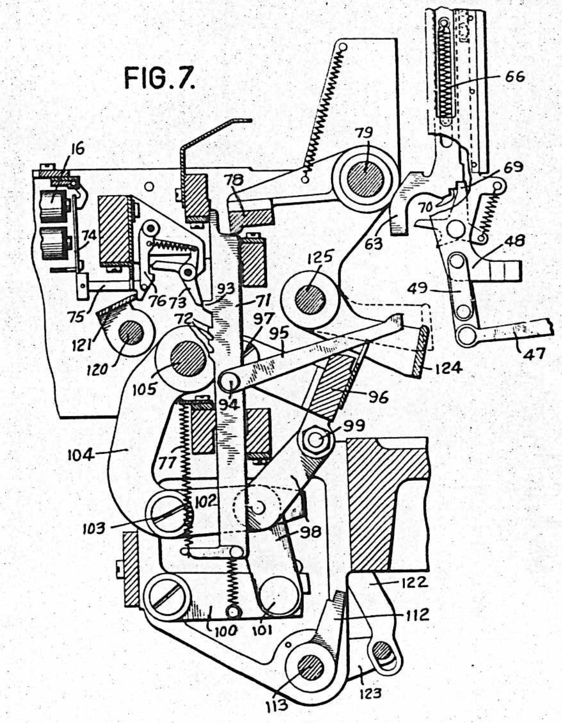

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FIG. 8.

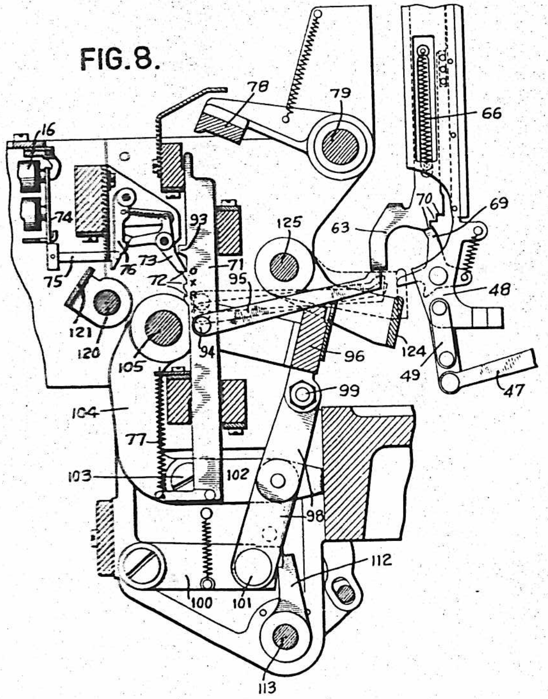

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FIG. 9.

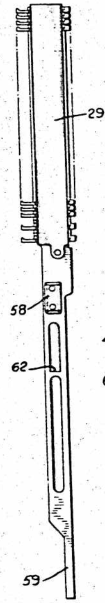


FIG. 10.

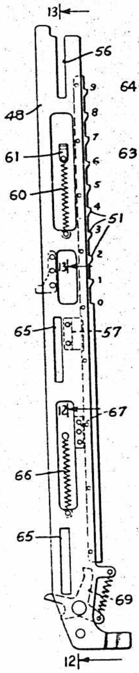


FIG. 14.

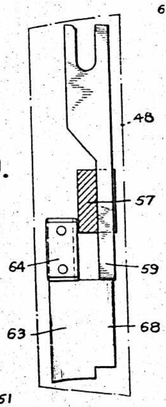


FIG. 11.

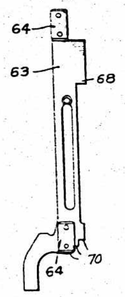


FIG. 12.

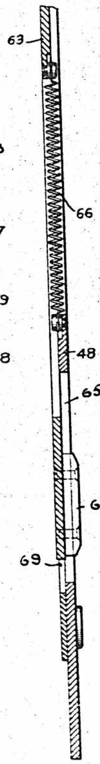
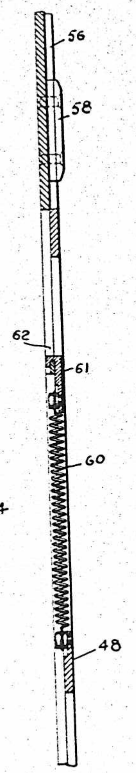


FIG. 13.



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Patented Oct. 8, 1935 2,016,682

UNITED STATES PATENT OFFICE

2,016,682

PRINTING MECHANISM

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Machines Corporation, New York, N. Y., a corporation of New York

Application September 24, 1932, Serial No. 634,690

10 Claims. (Cl. 101—93)

This invention relates to accounting machines and more particularly to the printing mechanisms thereof. The printing mechanisms of tabulating machines as presently developed are usually provided with type carriers which have arranged thereon a plurality of type elements, one for each of the digits and one for each of the letters of the alphabet and such other symbols as it may be desirable to print upon a record.

In machines in which type carriers of the reciprocating type are employed, the provision of alphabetical type elements increases the mass which must be reciprocated for each operation of the machine and also necessitates a longer stroke of the type carrier in order to cause each type element to pass the printing position with the result that the speed of operation and general efficiency of an alphabet printing machine is considerably less than a machine designed to print only the digits.

It is the main object of the present invention therefore to so construct and arrange the alphabet printing mechanisms of a tabulating machine to the end that the efficiency of the machine may be improved and the rate of operation considerably increased over that of previously constructed machines of this character.

A further object of the machine resides in the provision of a novel zoning mechanism which through improved construction and unique manner of operation permits the rapid and accurate selection of a particular alphabetical type element under control of perforations in a single column of a record card.

According to the present system, alphabetical characters are represented on the well-known Hollerith tabulating card by two perforations located in different index point positions of a single column of the record card. One of these perforations is known as the digit perforation and the other as the zone perforation. The record cards are passed through the usual card feeding and analyzing devices so that they pass a set of upper analyzing brushes and exactly one machine cycle later move in transit past a set of lower analyzing brushes. During the movement of the record card past the upper brushes, analysis is made of the zone perforation. Later in the operation of the machine, as the card passes the lower brushes, the digit perforations are analyzed. The separate analyses of both of the perforations control the positioning of the type carrier and type elements to select the alphabetical character represented by the particular arrangement of the perforations analyzed.

A further object of the invention is to provide a type carrier which is provided with a readily removable type head which will permit of the removal of the head and the substitution of a different head without dissembling the entire printing mechanism.

Various other objects and advantages of the invention will be obvious from the following particular description of one form of mechanism embodying the invention or from an inspection of the accompanying drawings; and the invention also constitutes certain new and novel features of construction and combination of parts hereinafter set forth and claimed.

In the drawings:

Fig. 1 is a central section of the printing mechanism of an alphabetical tabulating machine.

Fig. 2 is a plan section of the printing mechanism of the machine taken substantially along the lines 2—2 of Fig. 1.

Fig. 3 is a partial outside view of the printing mechanism showing some of the driving mechanism therefor.

Fig. 4 is a section taken on lines 4—4 of Fig. 2 showing the operating cams for the zoning mechanism.

Fig. 5 is a fragment of a record card showing the combinational arrangement of the perforations to represent the alphabetical characters and also the usual digit perforations.

Fig. 6 is a detail of the type head showing the manner of arrangement of the type elements thereon.

Fig. 7 is an enlarged detail view of the zoning mechanism shown in position preparatory to receiving a zone controlling setting.

Fig. 8 is a further position view of the parts shown in Fig. 7 showing the manner in which the zoning mechanism effects the operation of the type carrier.

Fig. 9 is a detail view of the type head.

Fig. 10 is a detail view of the type carrier to which the type head is resiliently connected.

Fig. 11 is a detail of a slider which is adapted to effect relative movement between the type head and the type carrier.

Fig. 12 is a detail sectional view taken substantially along the line 12—12 of Fig. 10 showing the manner in which the slider in Fig. 11 is connected to the type carrier in Fig. 10.

Fig. 13 is a detail sectional view taken substantially along the lines 13—13 of Fig. 10, showing the manner in which the type head of Fig. 9 is connected to the type carrier of Fig. 10.

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Fig. 14 is a detail showing the manner in which the type head of Fig. 9 and the slider of Fig. 11 cooperate after they have been separately mounted upon the carrier of Fig. 10.

Fig. 15 is a simplified circuit diagram showing the circuits which control the operation of the printing mechanism.

The arrangement of the perforations on the record card will first be explained. Referring to Fig. 5, the record card C has the usual perforations for indicating numerical values as shown at the left end of the card. The alphabetical characters from A to I are combinations of one of the numerical characters from 9 to 1 plus a perforation in the R index point position. The characters J to R each comprise a perforation in one of the numerical positions 9 to 1 plus a perforation in the X index point position. The remaining letters of the alphabet, namely S to Z, each comprises a combination including one of the perforations 9 to 2 plus a perforation in the O index point position. The record cards are placed in the card feed mechanism of the machine which is not shown but which may be of the type fully shown and described in Patent No. 1,827,259, granted to J. R. Peirce, October 13, 1931.

Fig. 15 shows the card analyzing elements of the card feeding mechanism diagrammatically as representing upper analyzing brushes UB and lower analyzing brushes LB past which the cards are traversed in succession. The upper analyzing brushes are controlled so as to analyze only the index point positions O, X, and R while the lower brushes may analyze all of the index point positions.

A representative circuit through the upper brushes may be traced from the left side of line 10 to the common contact roller 11, perforation in the record card C, analyzing brush UB, wire 12 to plug socket 13, thence through a suitable plug connection 14 to socket 15 and from there through a zone selecting magnet 16, wire 17, cam contacts 18 to right side of line 19.

A representative circuit through the lower brushes LB may be traced from line 10, wire 20, print magnet 21, plug socket 22, suitable plug connection 23, plug socket 24, wire 25, brush LB, perforation in the record card C, contact roller 26, wire 27, cam contacts 28, to right side of line 19. Cam contacts 18 and 28 are controlled by suitable controlling cams which are mounted on the operating shaft 31 of the machine.

In Fig. 6 is shown the type head 29 which is provided with a plurality of type elements 30 upon which the digits and alphabetical characters are arranged as indicated. For the purposes of explanation the various characters are arranged and labelled in accordance with a particular zone; thus the digits are included in zone 1, the letters A to I in zone 2, J to R in zone 3, and S to Z in zone 4.

Reference to Fig. 5 will show that the letters I, R, and Z each contain a perforation in the 9 index point position but have a different zone perforation O, X, and R. Similarly, the letters H, Q, and Y each contain the perforation 8 and a different zone perforation.

The type head is arranged to be moved past the printing position in synchronism with the movement of the card past the lower brushes and as the 9 index point position traverses the lower brushes, one of the characters I, R, or Z will be in printing position, depending upon the zone setting effected prior to the movement of the card past the lower brushes.

Referring now to Fig. 3, the main operating shaft 31 of the machine from which the card feeding mechanism may also be driven carries a gear 32 which through an idler 33 drives a gear 34 mounted upon a shaft 35. Secured to the shaft 35 is a pair of complementary cams 36 which are adapted to oscillate a bifurcated follower arm 37 secured to a rod 38 upon which is also attached an arm 39 which has link connection 40 to an arm 41 secured upon a shaft 42.

In Fig. 1, shaft 42 carries arms 43 which have depending link connection 44 with a bail 45 pivoted at 46. Also pivoted at 46 are type carrier actuating arms 47 which are connected at their free ends to the lower extremity of type carriers 48 through link connections 49. Arms 47 are urged in a clockwise direction by springs 50 which are connected at their upper ends to a cross bar extending between arms 43. Thus, as the arms 43 and bail 45 are rocked in a clockwise direction through the action of cams 36 the springs 50 will rock the arms 47 in the same direction and will cause elevation of the type carriers 48 which are suitably mounted for vertical movement. Each carrier 48 is provided with a series of stops 51 which, as seen in Fig. 10, are labelled 9 to 0 and which represent corresponding index point positions on the record card C. As the type bar 48 is moved upwardly, the stops 51 move past a stopping pawl 52 in succession. Pawl 52 is held in position in Fig. 1 by a latch 53 which has link connection 54 with armature 55 of print magnet 21. Energization of magnet 21 will trip latch 53 to permit pawl 52 to rock into engagement with the type carrier under the influence of its spring and engage one of the stops 51 to interrupt further upward movement of the type carrier. When a type bar is used to print numerical characters, it will, of course, be controlled by a column of the record card which contains but a single perforation in accordance with zone 1 of Fig. 5 and for such operation the type head 29 and the carrier 48 are maintained in the relationship to each other as shown in Fig. 1 and as the card is passing the lower brushes a circuit completed through the perforation will energize the magnet 21, as already traced in connection with Fig. 15, and will trip pawl 52 into engagement with the stop 51 corresponding to the location of the single perforation in the record card. This will result in the presentation of the corresponding digit type element to the printing line. The aforedescribed manner in which digits are selected for printing is substantially in accordance with the manner in which such digits are usually selected in this type of machine.

Where alphabetical characters are to be printed, the type head 29 will be displaced upwardly one, two or three steps with respect to the type carrier 48, accordingly as the character to be printed is contained in zone 2, zone 3 or zone 4, so that if, when the print magnet 21 is energized under control of a 9 perforation analyzed by the lower brushes LB, an R perforation had previously been analyzed by the upper brushes UB, the type head 29 will have been displaced upwardly one step thereby presenting the I type to the printing line rather than the 9 type. Similarly, if the perforation accompanying the 9 perforation had been in the X position, the type head 29 would have been displaced upwardly two steps to present the R type and in a similar manner the zone perforation of 0 accompanying the 9 perforation would effect an upward movement of the type head 29 three steps to place the Z type in printing position.

The manner in which the type carrier 48 and head 29 are constructed to permit relative movement between the two will now be explained after which the mechanism whereby such relative movement is effected will be fully set forth.

Referring to Figs. 1, 9, 10, and 11, the type carrier 48 is shown in Fig. 10 as being provided with a slot 56 and a guide 57 which are adapted to receive block 58 and lower end 59 respectively of the type head 29, the block 58 sliding within the slot 56, and the lower end 59 sliding in the guide 57. A spring 60 whose lower end is anchored to the carrier 48 is provided at its upper end with a hooked member 61 (see also Fig. 13) which, when the head 29 is slid upon the carrier 48 is adapted to be hooked over the lower edge of an opening 62 in the shank of the type head 29, the spring 60 thus tending to resiliently hold the head 29 in cooperation with the carrier 48.

Slidably mounted upon the lower portion of the carrier is a slider 63 (Fig. 11) provided with blocks 64 which cooperate with suitable openings 65 in the carrier 48. A spring 66 anchored at its lower end to the carrier and anchored at its upper end to the slider 63 (see also Fig. 12) tends to move the slider downwardly into engagement with a block 67 riveted to the carrier 48. With the parts assembled as in Fig. 1, spring 66 urges the slider 63 downwardly to cause the lower end of extension 68 on the slider to engage the block 67 on the carrier and spring 60 urges the type head 29 downwardly so that the lower end 59 thereof engages the upper edge of the extension 68 on the slider 63 (see Fig. 14).

After the machine has been completely assembled, it may be desirable to remove a type head 29 and replace it with another, in which event, it is simply necessary to unhook the spring terminal 61 and raise the type head 29 vertically out of engagement with the carrier 48. Inspection of the parts as assembled will show that if the slider 63 is moved upwardly, the head 29 will move likewise. A spring-pressed latch 69 pivoted at the lower end of the carrier 48 is adapted to cooperate with steps 70 integral with the slider 63 so that as the slider is moved upwardly with respect to the carrier, the latch 69 will cooperate with the steps 70 to hold the parts in their displaced relationship. The manner in which such displacement is automatically effected under control of the zone perforations will now be explained in detail.

Referring to Fig. 7, a plurality of vertically slidable combs 71 are provided of which there is one for each type carrier 48. Each comb is provided with three stops 72 which are adapted to be moved upwardly past a stopping pawl 73 in synchronism with the passage of the zone perforations O, X, and R past the upper brushes UB.

The zone magnet 16 which is energized under control of the upper brushes will, upon energization, attract its armature 74 to draw a link 75 toward the left to release a latch 76 and free pawl 73 so that its spring may rock it into engagement with one of its stops 72 to intercept further upward movement of the comb 71. Comb 71 is urged upwardly under the influence of a spring 77 and restored in a downward direction by a bail 78 secured upon a shaft 79 which in Figs. 2 and 4 also carries an arm 80 whose free end has a roller in cooperation with an arm 81 secured upon a shaft 82. Shaft 82 also carries a follower arm 83 in engagement with the cam 84 mounted upon shaft 85. Shaft 85 is driven from the main shaft 31 of the machine through gear connection comprising a gear 86 carried by the shaft 31 (see Fig. 3), idler 87 and gear 88 carried by shaft 89. In Figs. 1 and 2, shaft 89 carries a gear 90 at its other extremity which, through idlers 91, drives a gear 92 carried at one end of shaft 85. The cam 84 is thus driven in synchronism with the printing and card feeding mechanism of the machine and is adapted to make one revolution for each card feeding or printing cycle of the machine.

At the extremity of the downward stroke of comb 71, an extension 93 thereon is adapted to engage pawl 73 to re-latch the same upon latch 76. Comb 71 has pivoted thereto at 94, an arm 95 whose free end lies in the path of movement of the slider 63 and whose lower edge rests upon a bail 96 which is pivoted at 97. Under control of the zone perforations O, X, and R, the pivot point 94 of arm 95 may take one of three positions as indicated in Fig. 8. In this figure, the parts are shown with the comb 71 intercepted under control of a perforation in the O index point position under which condition the point of connection 94 assumes its lowermost position.

When the type carrier is in its lowermost position the bail 96 is adapted to be rocked in a counterclockwise direction to rock the arm 95 in a similar direction into engagement with the lower extremity of slider 63. It will be apparent that the distance which the free end of arm 95 is moved upwardly under control of the bail 96 is dependent upon the location of its pivot point 94 at such time. Thus, if the point 94 is located as shown in full lines in Fig. 8, the free end of arm 95 will be moved upwardly to its position of maximum height, the other two positions to which it may be moved being indicated in dotted outline. Thus a zone perforation in the O index point position will result in the movement of the free end of arm 95 three steps from its normal position; a perforation in the X index point position will cause it to move two steps; and a perforation in the R position will cause it to move one step. These steps of movement are, of course, transmitted to the slider 63 and it in turn will be moved one, two or three steps in accordance with the setting of the combs 71, the latch 69 carried by the carrier 48 serving to hold the slider in its displaced position with respect to the carrier.

Bail 96 is actuated through the medium of a toggle mechanism comprising links 98, one of which is pivoted to the bail at 99 and the other is pivoted to an arm 100 at 101. The point of connection of the links 98 carries an arm 102 which is also pivoted at 103 to an arm 104 secured upon a shaft 105.

Referring to Fig. 4, shaft 105 also carries an arm 106 which has link connection 107 to an arm 108 secured upon a shaft 109. Shaft 109 carries a follower arm 110 which is adapted to be actuated by a cam 111 secured upon shaft 85.

Referring to Fig. 7, an arm 112 carried by a rod 113 is adapted to be rocked from the position of Fig. 7 to the position of Fig. 8 prior to the straightening of the toggle links 98 so that when shaft 105 is rocked in a counterclockwise direction under control of its cam 111 the lower connection 101 of the toggle will be restrained against downward movement and the straightening of the toggle will move the point of connection 99 upwardly, causing the bail 96 to rock in a counterclockwise direction.

Referring to Fig. 3, rod 113 carries an arm 114 whose upper end is adapted to be engaged by the free end of an armature 115 of a magnet 116. Energization of magnet 116 will permit arm 114 to rock in a counterclockwise direction under the influence of its spring and thereby carry with it rod 113 and the arm 112.

Referring to the circuit diagram (Fig. 15) the magnet 116 is shown as connected in series with a pair of cam contacts 117 and a switch 118 between the lines 10 and 11. When the machine is used for alphabetical printing, the switch 118 is closed as shown and contacts 117 which are controlled by a cam mounted upon shaft 31 is adapted to close shortly after the R index point position has been analyzed by the brushes to energize magnet 116 and permit the effective operation of the toggle links 98. When the machine is used for numerical printing exclusively, the zoning mechanism may be partially disabled to lighten the operating load on the machine. Under such conditions, the switch 118 is opened or moved to its dotted line position shown in Fig. 15 so that the magnet 116 remains continuously deenergized. Referring to Fig. 7, the arm 112 will therefore remain continuously in the position shown and straightening of the toggle 98 through the action of the controlling cam will cause the pivot point 101 to move downwardly, arm 100 rocking about its pivot to permit such action while the pivot point 99 remains undisturbed.

Referring to Fig. 3, the shaft 79 has arm and link connection 119 with a shaft 120 which carries a bail 121 (see also Fig. 7). Through this connection rocking of shaft 79 to restore the combs 71 will be accompanied by clockwise rotation of bail 121 to restore latch 76 and armature 74 through the medium of link 75.

In Fig. 1 the shaft 120 is shown as having arm and link connection 122 with an arm 123 carried by rod 113 so that clockwise rotation of shaft 121 will cause movement of rod 113 in the same direction to re-latch arm 114 against the free end of armature 115.

As the type carrier 48 descends from printing position with the slider 63 held in displaced position by latch 69, it is necessary to first restore the slider to its lowermost position before effecting a new zone setting thereon. To this end a bail 124 is provided which is moved to the dotted line position shown in Fig. 7 before the type carrier reaches the lower extremity of its movement. In such position the bail 124 is in the path of an extension of latch 69 and as the carrier continues its descent, the extension of the latch will engage the bail 124 and cause clockwise rotation of the latch to release the slider 63 which under the influence of its spring will then return to its normal position. Following this action the bail 124 is lowered and the slider 63 is in readiness to receive a new setting under control of the arm 95.

The mechanism for controlling the operation of the bail 124 is shown in Fig. 4. Bail 124 is carried by a shaft 125 which through arm and link connection 126 is connected to an arm 127 secured upon shaft 128 which shaft also carries a cam follower arm 129 which cooperates with a cam 130 secured upon shaft 85.

The entire sequence of operations of the machine will now be briefly reviewed with reference to the printing of a particular alphabetical character. Assuming a column of the record card C to be perforated to represent the letter Z, reference to Fig. 5 will show that Z includes a perforation in the 9 index point position and in the O index point position. As the card begins its transit past the upper brushes, the combs 71 will be restored from the position they occupy in Fig 1 to the position of Fig. 7 and as the O, X, and R positions of the card approach the brushes, the comb 71 will be moving upwardly so that analysis of the O perforation will energize magnet 16 to trip stopping pawl 73 into engagement with the O notch 72 on the comb 71 intercepting the comb in the position of Fig. 8. The type carrier at this time is in its uppermost position effecting printing under control of a preceding card and is now returning to its lowermost position. As the carrier is descending, the bail 124 is moved upwardly and will engage the latches 69 and reset the parts to their normal position. Following this, the toggle links 98 are operated to rock bail 96 upwardly to transfer the setting of the arm 95 to the slider 63 which in the present instance will be moved to the position shown in Fig. 8, moving upwardly three steps as shown. Thereafter the carrier 48 moves upwardly as the card proceeds downwardly past the lower analyzing brushes LB and the uppermost step 51 (Fig. 1) of the type bar will be opposite the toe of stopping pawl 52 when the lower brush analyzes the 9 perforation causing the carrier to be intercepted at this point in which position the Z type element 30 is opposite the printing line. The printing hammers 135 are now tripped in the usual manner to effect printing on a suitable record.

It will be noted that the resilient connection between the type head and the carrier 48 which permits the ready removal of the head also makes for smoother and quieter operation of the mechanism in that as the type bar restoring bail 45 (Fig. 1) moves downwardly to restore the type bars, the shock of impact between the bail 45 and the carrier 48 is transmitted to the type head 29 through the connecting spring 60.

While there has been shown and described and pointed out the fundamental novel features of the invention as applied to a single modification, it will be understood that various omissions and substitutions and changes in the form and details of the device illustrated and in its operation may be made by those skilled in the art without departing from the spirit of the invention. It is the intention therefore to be limited only as indicated by the scope of the following claims.

What is claimed is as follows:

1. In a machine of the class described, a type bar, a type head slidably carried thereby which comprises a plurality of groups of type, means for moving said bar, means for intercepting said bar to select the type elements of one group for printing action, and electrically controlled means for causing a sliding action between said type bar and said type head before said bar is moved whereby said intercepting means will select the type elements of another group for printing action.

2. In a printing machine, a differentially positionable type bar having a stop thereon, a plurality of type elements carried by said bar and slidably movable thereon means cooperating with said stop for selecting said type elements for printing action and electrically controlled means for causing sliding movement between said elements and said bar in one direction only to determine which of said type elements is to be selected.

3. In a printing machine, a reciprocable type carrier, a type head comprising a plurality of

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groups of type slidably mounted on said carrier, means for differentially positioning said carrier to select the type of one of said groups, and electrically controlled means for changing the initial position of said type head with respect to said carrier prior to the operation of said positioning means whereby said positioning means will cause selection of the type of a different group.

4. In a printing machine, a type carrier movable from a rest position to printing position, a type head comprising a plurality of groups of type, slidably carried by said carrier, and electrically controlled means for effecting relative movement between said type head and said carrier while the latter is held in rest position whereby different groups of type will be effective for printing action in accordance with the extent of relative displacement between said head and said carrier.

5. A printing type bar including a carrier and a type head removably secured thereto, means for causing positive, relative positioning of said head with respect to said carrier and means carried by the carrier for holding said head and carrier in displaced relationship.

6. In a machine of the class described, record analyzing means for analyzing perforations in a record card, a carrier and a type head slidably secured thereto, means controlled by said analyzing means for causing positive differential positioning of said type head upon said carrier and means carried by the carrier for holding said head in displaced position upon said carrier.

7. In an accounting machine comprising in combination, a movable type carrier, having a plurality of type elements thereon, means for moving said carrier, card analyzing means, means controlled by said analyzing means in response to the analysis of a perforation in an index point position of a record card for causing positive relative movement between said type elements and said carrier and further means for controlling the movement of said carrier after the type elements have been moved relatively thereto.

8. In an accounting machine comprising in combination, a movable type carrier, having a plurality of type elements thereon, means for moving said carrier, card analyzing means, means controlled by said analyzing means in response to the analysis of a perforation in an index point position of a record card for causing positive, relative movement between said type elements and said carrier, and further means controlled by said analyzing means for subsequently controlling the extent of movement of said carrier and the relatively displaced type thereon.

9. In an accounting machine comprising in combination with a movable type carrier having more than two groups of type thereon common to a card column, controlling means whereby index points in a certain field of a controlling card effect relative movement between said carrier and said groups of type to select one of said groups and additional controlling means subsequently operative whereby other index points in another field of the card control the selection of a particular type in the selected group.

10. In an accounting machine comprising in combination a carrier having groups of type displaceably mounted thereon, analyzing brushes for analyzing a certain field of a record card to effect displacement of said groups of type with respect to said carrier to select a group of type concurrently with said analysis and an additional set of brushes for analyzing another card field to subsequently control the selection of a type of the selected group.

ALBERT W. MILLS.

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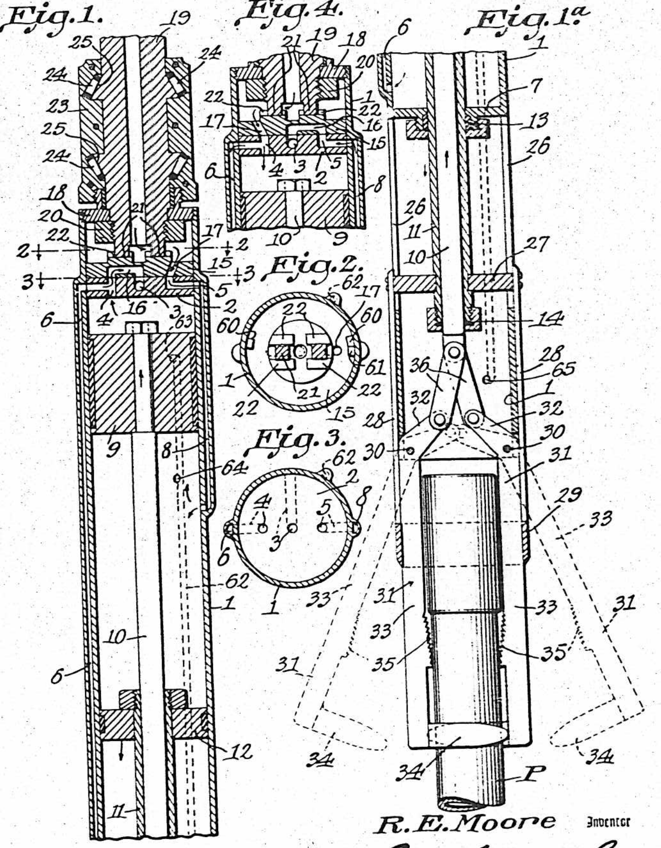
Oct. 8, 1935.　　R. E. MOORE　　2,016,683

FISHING TOOL

Filed May 21, 1934　　2 Sheets-Sheet 1



R.E.Moore　Inventor

By C.A.Snow & Co.

Attorneys.

/ Albert

Oct. 8, 1935. A. W. MILLS 2,016,682

PRINTING MECHANISM

Filed Sept. 24, 1932 7 Sheets-Sheet 4

FIG. 15.

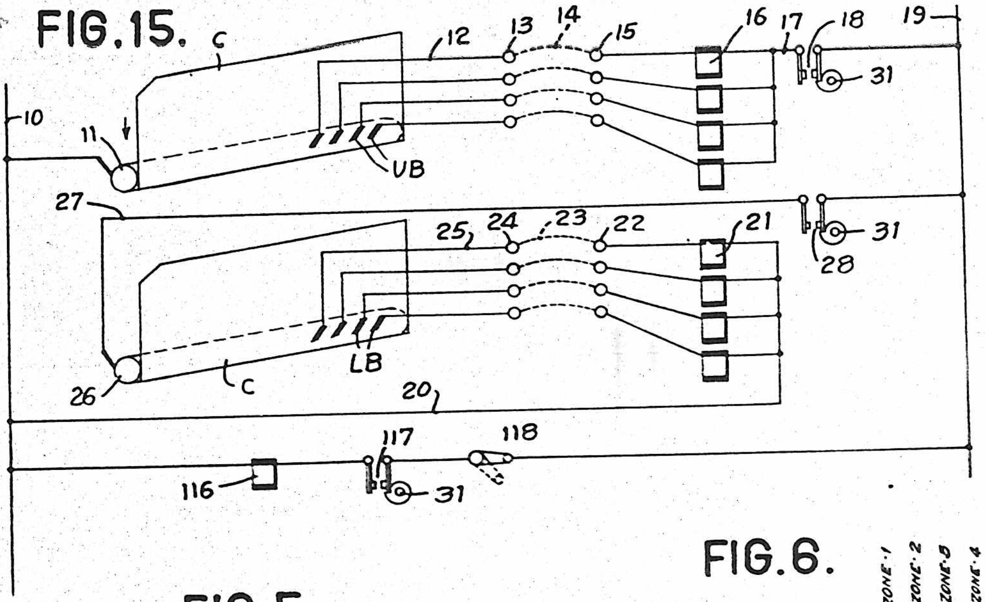


FIG. 5.

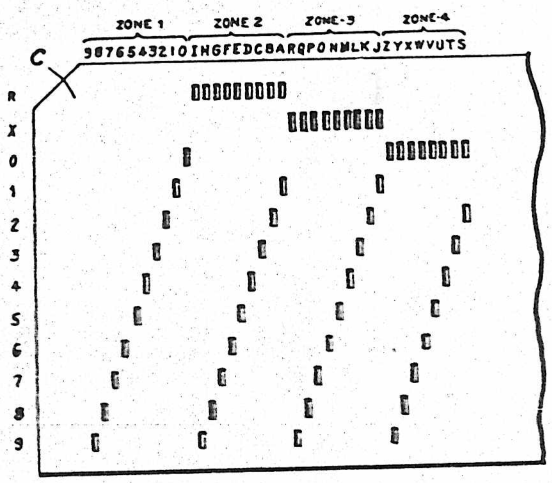
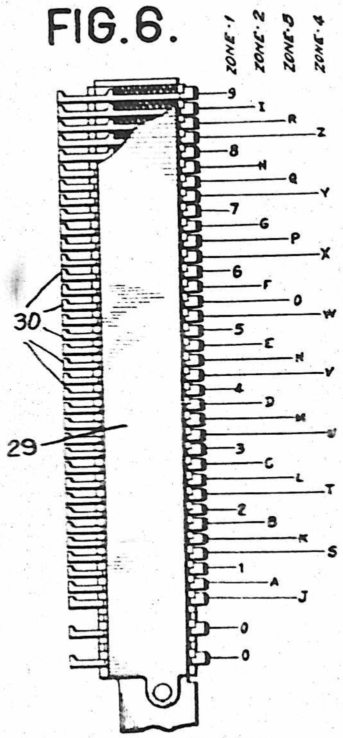


FIG. 6.



INVENTOR

Albert W. Mills

BY

ATTORNEY

Eugene

Oct. 6, 1936. **E. A. FORD** **2,056,394**

RECORD CARD CONTROLLED PRINTER

Filed May 7, 1935 7 Sheets-Sheet 5

FIG. 6.

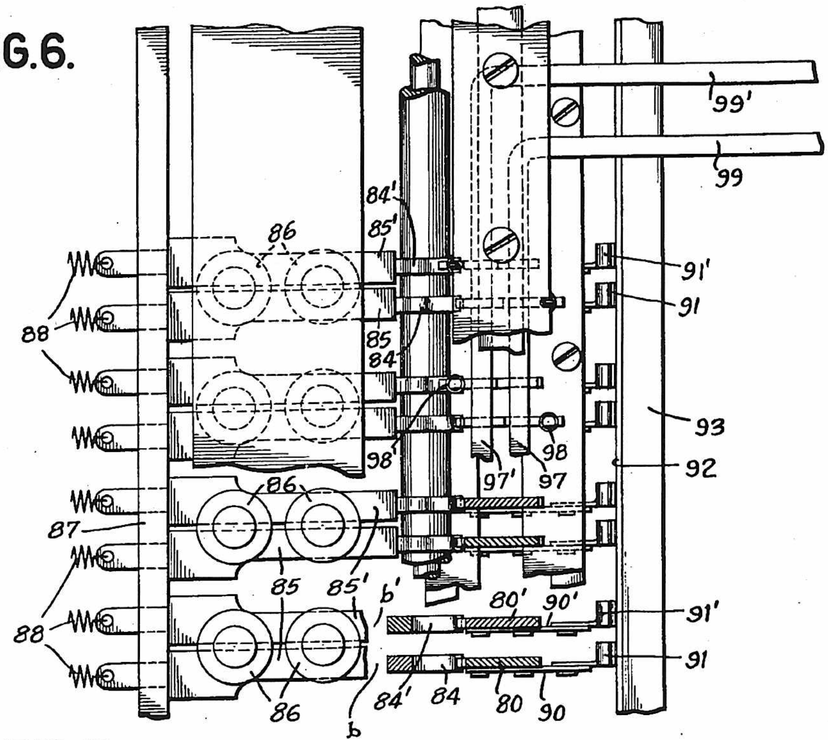
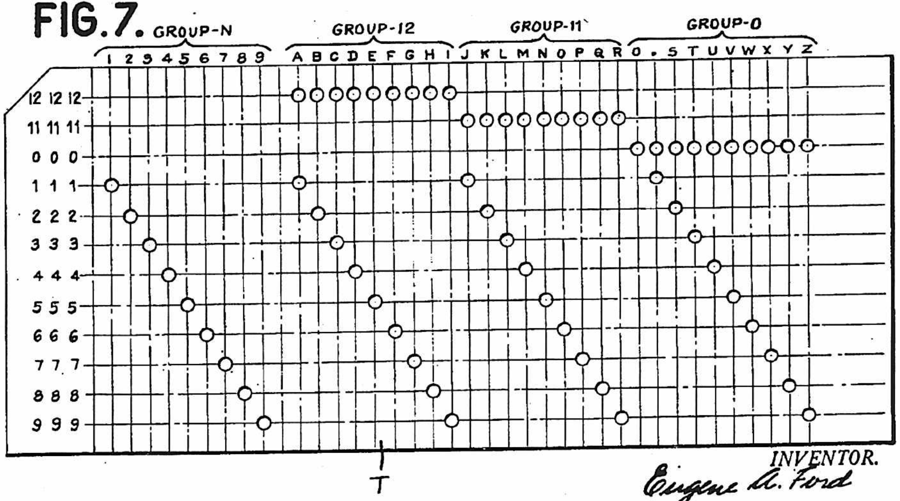


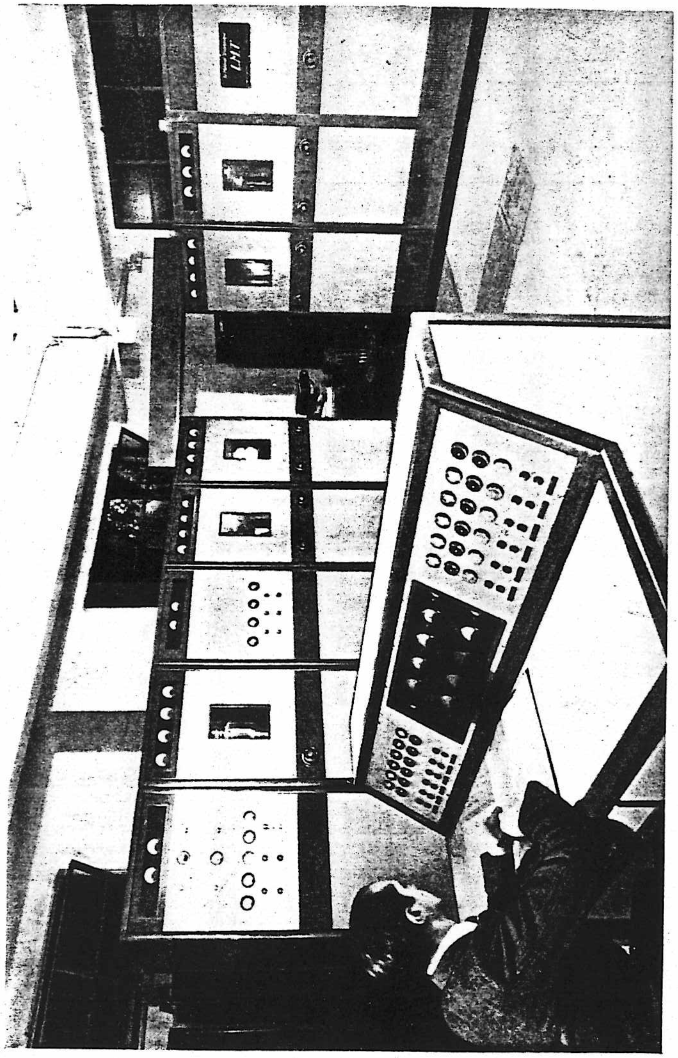
FIG. 7.



INVENTOR.
Eugene A. Ford

BY

ATTORNEYS.



The Eiffel Tower 30 kW Television Transmitter installed for the French P.T.T. by Le Materiel Téléphonique, Paris, was inspected in April by Press Representatives at the invitation of the Minister of the P.T.T.

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1937?

The Creed No. 10 Tape Teleprinter

Recent Advances in Printing Telegraph Technique

By A. E. THOMPSON,

Creed and Company, Ltd., London, England

INTRODUCTION

At no period in the history of the Telegraph have there been such revolutionary improvements in methods and equipment, or such rapid development and expansion in its service to the community, as during the past decade. This progress was initiated by the introduction of Teleprinter systems which, by providing instruments requiring no telegraphic skill on the part of operators, altered the whole outlook of telegraphy and stimulated development in all its branches.

All the older types of machine telegraph apparatus are rapidly being superseded by Teleprinters; and even hand Morse working—the backbone of telegraphy for more than a century—has now been entirely abandoned in the British Telegraph service, the bulk of the traffic being handled by Creed Teleprinters. A higher grade of service is consequently being rendered and substantial operating economies are being effected; furthermore, new and more profitable fields for exploitation have been opened up through the introduction of private wire and Teleprinter Exchange services.

With parallel developments in other countries, a "New Telegraphy" is being evolved, catering more adequately for the manifold needs of modern business. Thus the prestige of the telegraph services throughout the world is being enhanced and their prosperity restored.

The widespread adoption of Teleprinter systems has stimulated research and development, and has profoundly influenced design and construction technique by making possible the introduction of the most modern manufacturing methods for quantity production. By the application of machine tools, jigs and fixtures in the manufacture of apparatus parts, and functional gauges in the assembly of independent apparatus units, a high standard of uniformity and interchangeability has been attained and both manufacturing and maintenance costs have been substantially reduced.

In the design of Teleprinter systems there are many conditions to be fulfilled besides those necessary to meet the high standards of modern telegraph transmission. A machine may be suitable for use in telegraph offices under the constant supervision of a specialised personnel but it may not be adapted for use in ordinary business offices. A subscriber's machine must provide a dependable service at all times without requiring frequent routine adjustments or systematic lubrication. It must also incorporate certain supplementary operating facilities and be quiet in operation. In the case of news and ticker services, operation at high speeds is also required. It is primarily for providing such services with a faster and quieter instrument that the new Creed No. 10 Tape Teleprinter has been introduced.

DESCRIPTION

The No. 10 Teleprinter is a single-magnet receiving instrument, driven by an electric motor and designed for printing messages on a paper tape by means of a typewheel and ink-ribbon (Fig. 1).

It employs the Start-Stop principle for maintaining unison with the transmitting machine and operates on the Teleprinter signalling code in which each permutation of five selecting impulses is preceded by a start impulse and followed by a stop impulse (Fig. 2).

The printing speed has been set at 428 characters per minute (50 bauds), in order to work with other Teleprinter systems, but the printer can be operated at 20 per cent. higher speeds with an ample margin of safety.

In order to provide perfect printing visibility, a new and patented arrangement is used in

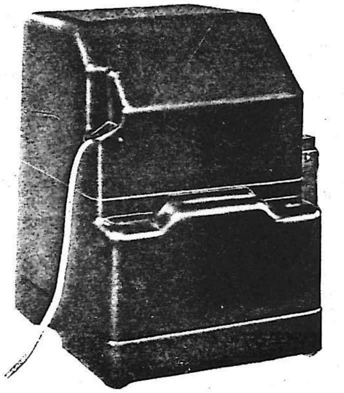

Fig. 1—No. 10 Tape Teleprinter.

which the typewheel is located underneath the paper tape with the printing hammer and typewriter ribbon above and at right angles to the tape. This arrangement also prevents the type becoming clogged since it does not come into contact with the ink-ribbon.

Contacts are provided for operating a calling bell by a predetermined signal permutation; also for controlling an "answer-back" device.

The motor is started by the first incoming signal and automatically stopped after transmission has ceased. It is located beneath the printer; both units are mounted on a patented system of spring suspension (Fig. 3).

Where a regulated frequency A.C. power supply is available, a synchronous motor can be used. With D.C. supply, or where an A.C. supply is not suitable for synchronous motors, the speed of the motor is maintained constant within ±0.5 per cent. by a centrifugal governor requiring negligible maintenance.

The motor is coupled to the printer by a centrifugal clutch of patented construction, in order to avoid the need for high starting torque. It starts on no load, and reaches approximately half its normal speed before the clutch operates and drives the printer.

The tape roll holder is located outside the cover of the instrument and includes a simple device for preventing paper fluff entering the mechanism.

Where transmitting equipment is required, the motor and printer are mounted side by side on a base to which a keyboard with four rows of keys and an automatic "shift" insertion mechanism* can be fitted. This combined sending and receiving instrument, the Model No. 10-B Teleprinter, is shown in Figs. 4 and 5. Alternatively, a simpler keyboard with only three rows of keys, arranged for manual "shift" operations, can be furnished.

DESIGN AND CONSTRUCTION

The design requirements of the No. 10 Teleprinter were determined by the need for providing a Teleprinter suitable for high speed news and ticker services. The following were among the more important considerations:

(1) Reliable service at a speed of 85 words per minute;
(2) Low manufacturing and maintenance costs;
(3) Quiet operation;
(4) Small dimensions.

The No. 10 printer is radically different in design from other Creed Teleprinter systems and incorporates mechanisms entirely new in the printing telegraph art. It employs the principle of aggregate motion. The difficulties encountered in earlier efforts of telegraph inventors to apply this simple and positive method of controlling a typewheel were successfully overcome by evolving a novel patented system of epicyclic gearwheels, operating by means of ratchet clutches in a manner which imparts harmonic motion to the individual gear-wheels and the typewheel. Hence, comparatively noiseless operation is achieved.

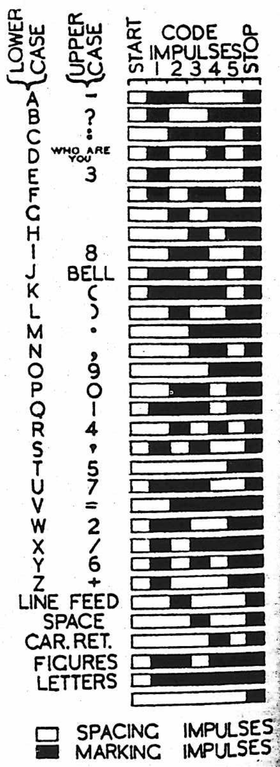

Fig. 2—Teleprinter Signalling Code.

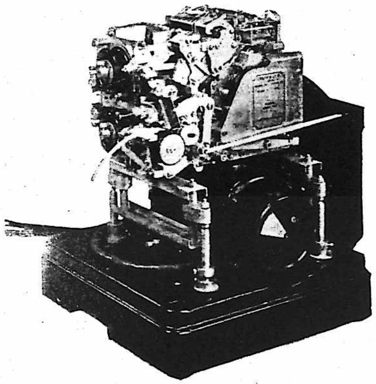

Fig. 3—No. 10 Tape Teleprinter—Cover Removed.

Manufacturing costs have been reduced by the extensive use of stampings, die castings and bakelite mouldings. Maintenance costs have been reduced by evolving mechanisms with a breakdown speed well above 100 words per minute.

The printer is designed to operate continuously for periods of 300 hours without requiring lubrication. Ball bearings and oil impregnated bearings, as well as sliding surfaces lubricated by means of oil reservoirs, are used.

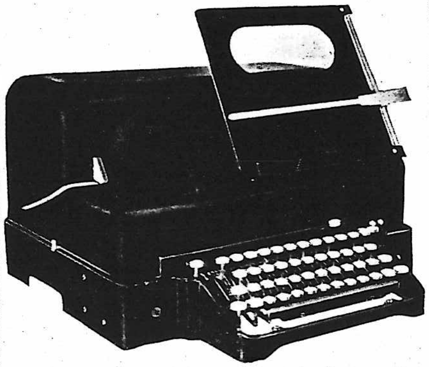

Fig. 4—Combined Sending and Receiving Instrument—10-B Teleprinter.

Seven major apparatus units are involved:

1. The Electro-Magnet;
2. The Main Frame unit, which comprises the Signal-Selecting and Distributing mechanisms;
3. The Translator, or Typewheel-control, unit;
4. The Printing unit;
5. The Ink-ribbon unit;
6. The Motor and Speed Governor;
7. The Main Base.

These units are strictly interchangeable and can be readily taken apart or reassembled. Parts which may require adjustment are easily accessible.

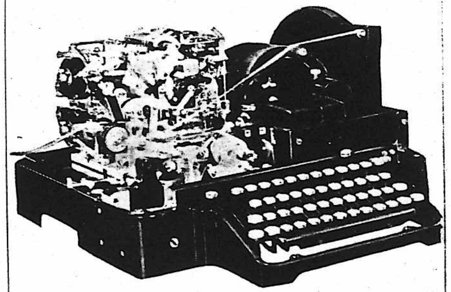

Fig. 5—Combined Sending and Receiving Instrument—10-B Teleprinter—Cover Removed.

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* "Improved Teleprinter Keyboard Technique," by F. R. Thomas, *Electrical Communication*, July, 1934.

The printer in block schematic form is illustrated in Fig. 6.

Operating Margin

In Teleprinter communication the signal elements representing each character are transmitted continuously in accurately timed sequence, but in passing over the telegraph channel they may be deformed by unequal attenuation of the high frequency components or other causes. In order that the receiving instrument may correctly identify deformed signal elements, the selecting mechanism, which tests their polarity, must utilize the smallest possible part of the mid-portion of each element. The smaller the part utilized, the greater is the "margin" of the printer. For example, where the selecting period is 6 milli-seconds, and the signal elements being transmitted are of 20 milli-seconds duration (50 bauds), the margin of the receiving instrument is ± 35 per cent. This is the value fixed by the C.C.I.T. for the margin of Teleprinter systems operating over international lines.

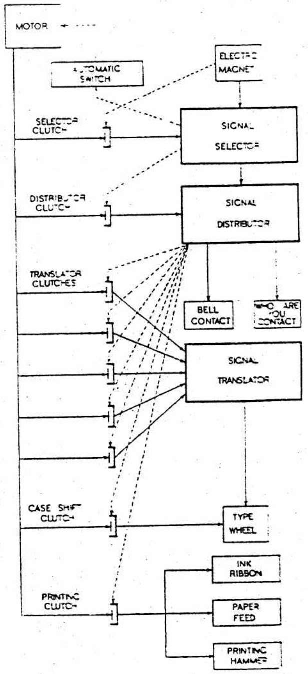

Fig. 6—Block Schematic of No. 10 Teleprinter.

The No. 10 Teleprinter requires a selecting period of only 3.2 milli-seconds; therefore, its margin is ± 42 per cent.

Signal Selector

High precision in identifying the polarity of distorted signal elements is achieved by means of a knife-edge member which, at the instant of selection, strikes a co-operating knife-edge on a fork-shaped extension of the electro-magnet armature and locks it in a position corresponding to the signal element received. A sword selecting member then strikes the fork and is tilted about its pivot in a clockwise or an anti-clockwise direction, according to which arm of the fork it engages. Having thus identified the signal element, the sword rises and transfers its setting to the control member of the distributor.

Signal Distributor

This distributor unit comprises a camshaft with co-operating control levers for positioning five transfer bars. These are set successively into one of two endway positions according to the polarity of the five signal elements of the character to be printed.

Signal Translator

When all five transfer bars have been set, they are caused to act simultaneously upon the translating mechanism composed of five half-revolution ratchet clutches which drive the planet pinions of a system of five epicyclic gear-wheels. The latter are interconnected in a manner such as to form an aggregate-motion system which translates the permutations stored by the transfer bars into corresponding rotary movements of the typewheel, thus bringing the selected character to the printing position.

Printing and Tape Feed

The printing unit is controlled by a cam-operated lever which also actuates a correcting device for ensuring that the selected character on the typewheel is accurately positioned.

The printing hammer is located at the end of a heavy bar. A co-operating helical spring causes the hammer to deliver a sharp and powerful impact.

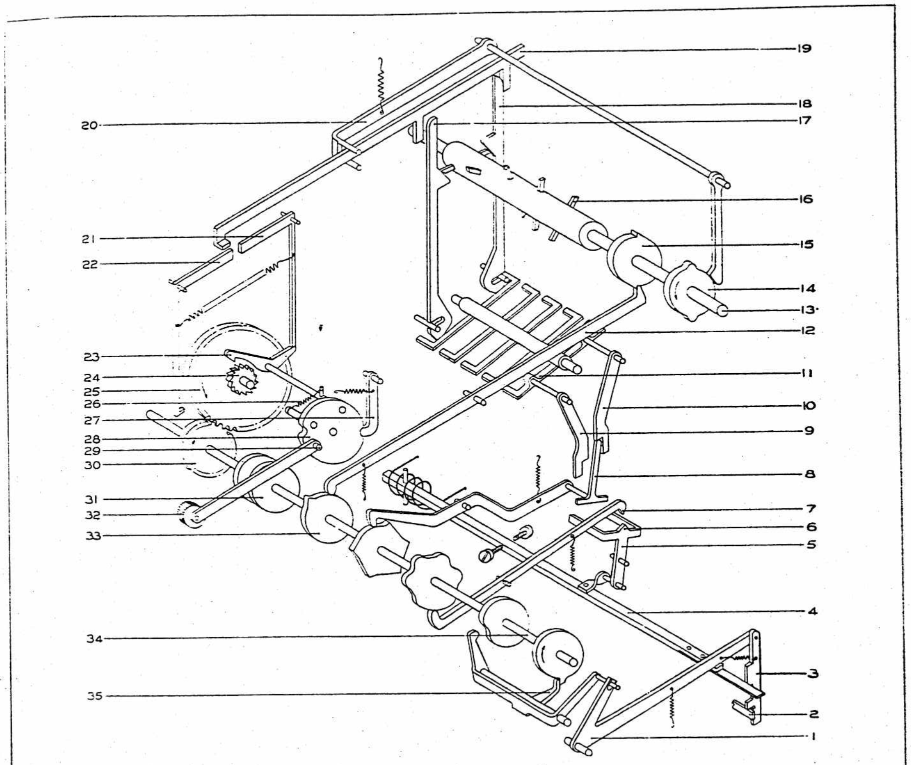

Fig. 7—Selector and Distributor.

During the return movement of the printing unit, a pawl and ratchet wheel are actuated to move the tape forward.

"Shift" and Subsidiary Functions

The upper and lower case characters are arranged in two rows on the typewheel. The means provided for bringing the selected row of type underneath the printing hammer include a half-revolution clutch which causes the typewheel to be moved axially according to the setting of the transfer bars.

Feeding of the paper tape and the operation of the printing hammer do not occur when the typewheel is set in a functional position, such as figure or letter shift.

Closure of the contacts for operating the calling bell is under the direct control of the transfer bars. Similar means are provided for releasing the "answer-back" mechanism incorporated in the keyboard of the No. 10-B model.

Automatic Motor Switch

The mechanism of the motor switch is simple and does not impose any load on the armature of the electro-magnet. It comprises a system of levers, a tripping latch and a control cam. Immediately the first code impulse is received, the releasing bellcrank of the selector control-shaft trips the latch-arm of the motor control unit from its stop and so causes the motor to be switched on. Subsequent "Start" impulses prevent the latch-arm from re-engaging its stop, the motor thus remaining in operation.

When transmission has ceased, the latch-arm re-engages its stop and causes a slowly rotating cam to actuate a lever for switching off the motor.

Ink-ribbon Feed

The ink-ribbon is carried around the printing unit and passes between the printing hammer and the paper tape. It is automatically fed forward, the reversing mechanism being positive in operation. The spools are conveniently located one above the other on the left side of the printer and the ribbon can, therefore, easily be changed.

Cover and Base

The No. 10 Model is totally enclosed in a silencing cover, a small strip of glass being provided between the printing point and the tape outlet. The temperature inside the cover is kept at a low level by fan-driven air circulation, the heat from the motor being driven out through a special chamber in the base of the printer.

The cover of the No. 10-B model is hinged at the back and can be raised or lowered without breaking the tape. It is cut away at the printing point to ensure good visibility and to facilitate tearing off the tape. The rear side of the base provides a convenient apparatus compartment for the wiring, resistances and condensers, and is protected by a metal plate which can be taken off by removing two screws.

PRINCIPLE OF OPERATION

Referring to Fig. 7, the armature 4 of the electro-magnet is connected by a link to the selecting fork 5 and also carries an extension co-operating with the starting latch 3. When a "Start" impulse is received, the armature pushes the starting latch away from the supporting member 2. This causes the lever 1 to withdraw the control detent 35, thus releasing the camshaft 34 which is frictionally driven by the clutch 31 and allowed to make one revolution.

Selection

The movements of the armature rock the selecting fork about its pivot and are identified when the knife-edge 7 strikes the co-operating knife-edge 6, thereby locking the fork until the selecting sword 8 has been set. The sword strikes five times during one revolution of the camshaft. In its downward travel, its horizontal arm engages one arm of the selecting fork, according to the position of the armature, and the vertical arm of the sword is thus deflected either to the left or right.

Distribution

Upon being raised, the sword engages one or other of the distributor control links, 9 or 10, to position the rocking member 11.

When the right-hand side of the rocking member is uppermost, its arms embrace the lower ends of the five operating levers 18 (one only is shown); and, when tilted in the opposite direction, its arms embrace the lower ends of the five operating levers 17.

The cam 33, by means of the lever 12 and detent 15, releases the frictionally-driven shaft 13 which turns through half a revolution during the five settings of the rocking member. The cams 16 pass the contact faces of the two sets of operating levers, 17 and 18, in sequence and cause these levers to be spread outwards. When the levers are restrained at their lower ends by the rocking member, they are moved outwards at their upper ends, carrying with them their associated transfer bars 19.

Translation

When the transfer bars have all been positioned, their supporting member 20 is actuated by the cam 14. Each transfer bar thereupon depresses one or other of its associated detents, 21 or 22, to enable the driving pawl 23 to engage the ratchet wheel 24. The latter is fastened to the gear, 25, which is driven continuously by gear 30.

The driving disc 28, carrying the pawl 23, spring 26 and crank pin 29, is mounted coaxially with gear 25 and rotates with it when the pawl and ratchet wheel are in engagement. The pawl 23 is held against the tension of the spring 26 by the retaining lever 27.

In the position shown, this pawl is held out of engagement with the ratchet wheel by the detent 21. Upon the latter being actuated by its transfer bar, the pawl engages the ratchet wheel and the driving disc makes half a revolution. It is stopped when the pawl is thrown out of engagement with the ratchet wheel by striking the opposite detent 22.

The driving discs, 28, actuate the planet-pinions 32 of five epicyclic gear units. Referring to Fig. 8-A, these units each comprise an inner sun-gear, a planet-pinion and an outer sun-gear. The outer sun-gear of each unit is connected to the inner sun-gear of the next unit, the gear ratios being such that the angular movements of the outer sun-gears are halved when transferred from one unit to the next.

The fifth sun-gear is connected to the typewheel by intermediate gears so proportioned that, when driving disc 5 rotates 180 degrees, the typewheel also rotates 180 degrees (Fig. 8-B).

The step down in angular movement at each stage is indicated in Fig. 8-C. Driving disc 4 has rotated 180 degrees but the resulting movements of the planet-pinion and sun-gear of the fifth unit are such that the typewheel has only rotated 90 degrees.

Similarly, when the driving disc No. 3 is actuated, the step down at the succeeding stages results in the typewheel being rotated through 45 degrees (Fig. 8-D).

When driving disc No. 2 is actuated, the typewheel rotates one-sixteenth of a revolution; and, when No. 1 is actuated, the typewheel rotates one-thirty-second of a revolution, or one character. It will be seen, therefore, that by operating the five driving discs in accordance with the permutations of the five-unit code, it is possible to select any one of thirty-two positions of the typewheel.

Among the advantages of this method of controlling the typewheel are the following:

(1) Since the connecting rods of the planet-pinions are driven by rotary clutches, the movements are all harmonic; hence, the typewheel is accelerated and brought to rest without shock;
(2) The typewheel is positioned positively;
(3) In passing from one code permutation to another, the mechanical movements are reduced to a minimum since only the particular code elements actually changed affect the mechanism;
(4) The typewheel can rotate in either direction and so moves directly from one character to the next;
(5) The mechanism is practically noiseless in operation.

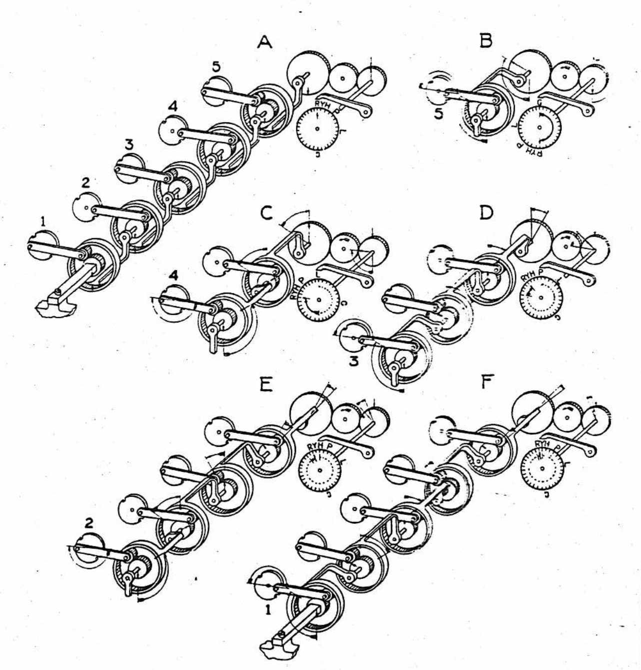

Fig. 8—Epicyclic Translators.

Printing

Referring to Fig. 9, when the selected character on the typewheel has been brought to the printing position, the cam 39 actuates the lever 40. This raises the end of the bellcrank 43, thereby extending the spring 42 and causing

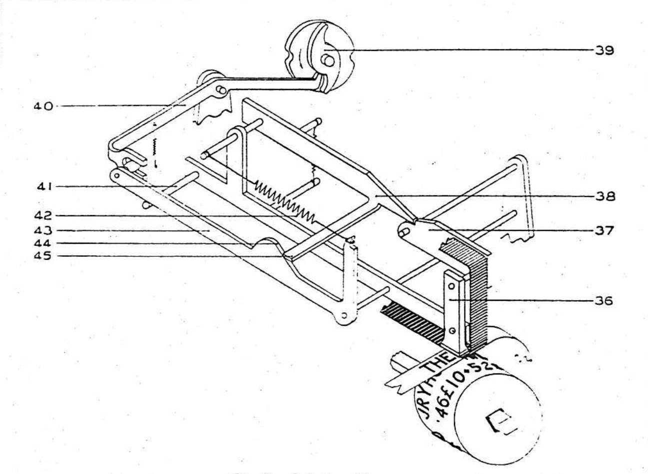

Fig. 9—Printing Hammer.

the trigger 45 to ride up on the cam surface 44. The latch 38 is thus forced out of engagement with the abutment 37 and the stressed spring instantly causes the hammer 36 to strike the ink-ribbon and the paper tape against the typewheel.

The mechanism is re-set by the depression of the pin 41 upon the return of the bellcrank 43.

TIMING OF OPERATIONS

The sequence of the mechanical operations and their time intervals are indicated in Fig. 10. The movements of the armature of the electromagnet correspond to the letters Y and T, it being assumed that the code impulses are received free of distortion and are therefore square-topped. The effect of distortion is to displace the moment of transit of the armature, either forwards or backwards, and it will be observed that, provided the displacement does not encroach upon the middle portion of the impulses indicated by the shaded vertical lines over a period of 3.2 m.s., the signal selector will correctly identify the polarity of the impulses.

The first movement of the armature, in responding to the start impulse, releases the signal selector camshaft, which completes one revolution in 130 m.s. and is then arrested by the stop signal. The commencement of rotation of this camshaft is shown near the middle of the start signal, thus allowing for the time required for the armature to release the camshaft detent and for the camshaft to accelerate and reach full speed.

The first cam on the signal selector actuates the knife-edge member which locks the armature while the sword is being positioned. It will be observed that the transit from the free to the locked condition occurs at the mid-portion of each code impulse.

While the armature is locked the sword descends and, having been set in accordance with the polarity of the code impulse, it rises again and positions the distributor rocking member. The upward movement of the sword is so timed that it is just clear of the armature at the moment the latter is unlocked.

The signal selector also carries a cam for effecting the release of the distributor shaft. The latter carries five cams which are timed to position the five transfer bars during the successive periods when the sword is in engagement with the rocking member.

The distributor camshaft carries two other cams: one adapted to actuate the transfer bars to release the clutches of the epicyclic unit immediately after the fifth transfer bar has been set; the other, to release the printing camshaft 20 m.s. later.

The rotation of the typewheel from one printing position to the next occupies 118 m.s. During this period the cam on the printing unit extends the printing hammer spring and retracts the paper feeding pawl, simultaneously advancing the corrector tooth towards the corrector wheel. When the typewheel comes to rest the corrector tooth enters the corrector wheel, thus holding the typewheel in the precise printing position. Whilst the correcting action is taking place, the printing hammer is released to strike the paper immediately the typewheel is accurately positioned. The return movement of the printing hammer takes place under the action of the retractile spring after the cam has come to rest. This movement also acts to feed the paper.

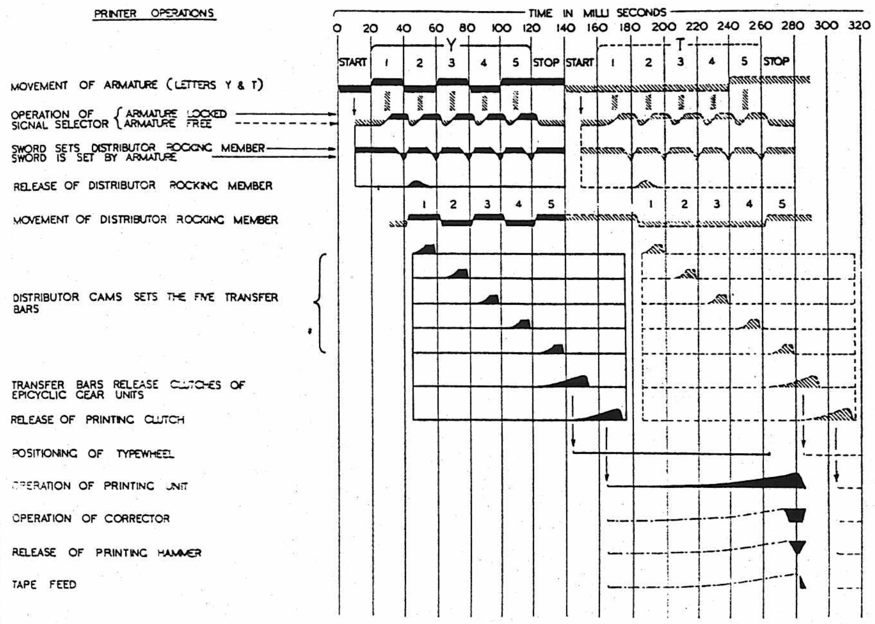

Fig. 10—Sequence of Mechanical Operations and Time Intervals.

It will be observed that there is complete overlap between the operation of the signal selector and the translator unit. While the epicyclic gears are rotating to advance the letter Y to the printing position, the succeeding letter T is being received and stored by the five transfer bars in readiness to release the clutches of the epicyclic gears immediately the letter Y has been printed.

CONCLUSION

The mechanisms incorporated in the No. 10 Teleprinter are the outcome of several years of continual study and experiment undertaken to evolve the design requirements of a printer that is not only capable of operating at higher speeds than existing types, but also of providing quieter operation and more economical maintenance. Wide factors of safety have been provided throughout the machine, and the reliability and durability of the component mechanisms and parts have been proved by rigorous tests. It may be confidently anticipated, therefore, that this new instrument will fulfil all the requirements of a highly modern Tape Teleprinter, suitable for use by Telegraph Administrations and private companies, as well as by high speed news and ticker services.